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Forest Vegetation of the Medicine Bow National Forest in Southeastern Wyoming: A Habitat Type Classification

Robert R. Alexander, George R. Hoffman, and John M. Wirsing

Abstract

A vegetation classification based on concepts and methods developed by Daubenmire and refined by others was used to identify 16 forest habitat types on the Medicine Bow National Forest. Included were two habitat types in the *Pinus flexilis* series; three each in the *Pinus ponderosa, Populus tremuloides*, and *Abies lasiocarpa* series; and five in the *Pinus contorta* series. A key to identify the habitat types and the management implications associated with each are provided.

Cover Photo.—Snowy Range, Medicine Bow National Forest.

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Forest Vegetation of the Medicine Bow National Forest in Southeastern Wyoming: A Habitat Type Classification

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Contents

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Forest vegetation on the Medicine Bow National Forest and adjacent areas is a diverse mixture of plant communities which responded differently to environmental and biological conditions. This forest vegetation has been described previously to a limited extent. In 1915, Rydberg described the forest vegetation of the Rocky Mountains, but limited his observations to the zonal occurrence of different tree species. Blake (1945) made an ecological reconnaissance of the Medicine Bow Mountains near the Libby Flats area. As part of this study, he provided a limited description of the *Picea engelmannii-Abies lasiocarpa* plant community, but made no attempts to identify shrub and herbaceous layers.

In 1952, Oosting and Reed studied a *P. engelmannii-A. lasiocarpa* plant community in the Snowy Range area of the Medicine Bow Mountains. In contrast to the results of the present study, they concluded that these forests were composed of a floristically uniform and ecologically simple plant association (*Abies lasiocarpa/Vaccinium scoparium*). Porter (1962) described the forest types in Wyoming and recognized more floristic complexity in the undergrowth. Romme and Knight (1981) described the subalpine forest vegetation in the undisturbed 11,120-acre (4,500-ha) upper Savage Run Watershed, but only made limited reference to the undergrowth.

Adjacent to Medicine Bow National Forest to the south, Hoffman and Alexander (1980) described 11 habitat types on the Routt National Forest. Five of these occur on the Medicine Bow National Forest. On the Arapaho and Roosevelt National Forests, Hess and Alexander (1986) identified 30 habitat types. Ten of these also occur on the Medicine Bow National Forest.

In 1970, a cooperative study was started by Wirsing (1973) to (1) identify and describe forest habitat types on the Medicine Bow National Forest, (2) relate habitat types to topographic, edaphic, and climatic factors, (3) describe successional patterns of forest vegetation, and (4) relate Medicine Bow habitat types to other Rocky Mountain forests with similar classifications. The original classification completed in 1972 (Wirsing 1973, Wirsing and Alexander 1975) was based on concepts and methods developed by Daubenmire (1952), and refined and extended by Daubenmire and Daubenmire (1968) and others.

The original classification (Wirsing 1973, Wirsing and Alexander 1975) identified and described five habitat types and two community types. During the past 10 years, attempts to use this classification indicated that it did not identify all of the forest habitat types on the Medicine Bow National Forest. In 1985 and 1986, George R. Hoffman and Robert R. Alexander reanalyzed Wirsing's original data set. The results reported here represent this effort. The revised habitat type classification is intended for two primary audiences: forest managers and land-use planners who want a working tool for planning and decisionmaking, and ecologists who want a research tool to use in related studies. Not all readers will find each category of information of equal value.

STUDY AREA

The Medicine Bow National Forest is within the mountainous areas of southern Wyoming. This forest, totaling more than 1.09 million acres (441,300 ha), exclusive of the Thunder Basin National Grasslands, is composed of four physiographic areas separated by extensive basins and low, broad valleys (fig. 1). Table 1 shows the size, elevation, and principal vegetation of each area.

PHYSIOGRAPHY AND GEOLOGY

The Snowy Range, part of the Medicine Bow Mountain Range, about 30 to 35 miles (48 to 56 km) west of Laramie, extends approximately 35 miles (56 km) north of the Colorado-Wyoming border. Extensive Precambrian gneiss and igneous rock underlies most of the range (Thornbury 1965). Rising rapidly from the western flank of the Laramie Basin, this range reaches its highest point [12,000 feet (3,658 m)] on Medicine Bow Peak (table 1). The Medicine Bow Mountain Range is bordered on the east by the Laramie Basin, which contains sedimentary rocks ranging in age from Paleozoic to Recent, and on the west by the North Platte Valley, which contains principally sedimentary rocks of Tertiary Age. Glacial drift of Pleistocene time is abundant in the northern portion of the Snowy Range, where it originated from an ice cap near Medicine Bow Peak (Houston 1968). As a result, numerous streams and lakes are found in this area. In the southern portion, very little glacial action took place.

Across the North Platte Valley to the west lies the Sierra Madre, which extends for 40 miles (64 km) along the Colorado-Wyoming border and 20 miles (32 km) north of the state line. Rolling hills and less precipitous, lower mountains than those found in the Snowy Range characterize this area (table 1). It is bordered on the north and east by sedimentary bedrock of Tertiary origin, and it is rimmed in the west and southwest by igneous rock of Tertiary volcanic origin. Precambrian bedrock also underlies most of this region (Thornbury 1965).

Pole Mountain, an important recreation area, is east of Laramie. It consists mainly of rolling hills, with a few rugged areas (table 1). The Sherman Mountains, located in the southwest portion of the unit, are considered to be erosional remnants (Monadnocles) rising above the general level of the surface of the Laramie River. The underlying bedrock is Precambrian granite. The southern section of the area is covered with peculiar rock formations caused by planes of weakness in the granite, dividing it into blocks, and is capped with balanced rock. In contrast, sedimentary bedrock of Paleozoic origin underlies the northwest section of the area. High plains border this part of the Medicine Bow National Forest on the east and west, with rolling hills to the north and south.

Located in the northern-most extension of the Laramie Mountains about 100 miles (161 km) north of Laramie, the Laramie Peaks area is bordered on the north and east by high plains and on the west by Shirley Basin. To the south, it gradually extends into the Pole Mountain area (table 1). The topography can be characterized as very rugged, with most of the region containing bedrock of Precambrian origin (Thornbury 1965). This area is an important water, grazing, and recreation area for surrounding ranches and communities. Ownership of the land is often patchy between Medicine Bow National Forest, private, and state lands.

CLIMATE

Mean annual precipitation on the Medicine Bow National Forest varies from about 15 inches (38 cm) at 6,000 feet (1,830 m) elevation to 25 inches (64 cm) or more at 10,000 feet (3,050 m) elevation. At lower elevations, about three-fourths of the precipitation falls, mostly as rain, during the period April through September, while at elevations above 8,000 feet (2,440 m), about two-thirds of the annual precipitation falls as snow during the period October through May (U.S. Department of Agriculture 1930).

Mean annual temperature in the Pinus ponderosa forest zone is about 45 °F (7 °C), with a maximum range of –40 °F (–40°C) to 110 °F (43 °C). In the *Picea engelmannii-Abies lasiocarpa* forest zone, mean annual temperature is less than 35 °F (2 °C), and frost can occur any month of the year. Temperature varies from –50 °F (–46 °C) to about 90 °F (32 °C) (U.S. Department of Agriculture 1930).

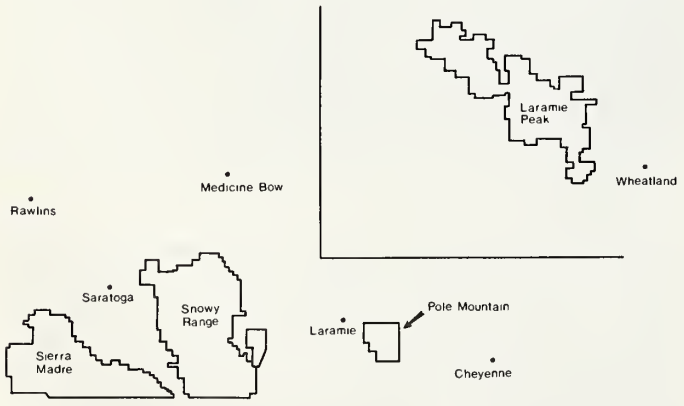

Figure 1.—Study areas on four physiograhic units of the Medicine Bow National Forest, Wyoming.

The limited temperature and precipitation data from published records are useful in characterizing the Medicine Bow National Forest in broad, general terms. However, mountainous topography produces so much variation in temperature and precipitation that it is difficult to obtain much meaningful climatic information for a given locality without direct on-site measurements.

METHODS

Preliminary work to classify forest vegetation in the Medicine Bow National Forest was begun in the summer of 1970. A total of 221 reconnaissance plots were located to sample the various tree species present over a wide geographic area. For each plot, environmental factors, such as location, elevation, aspect, and percent slope, as well as a representative list of the trees, shrubs, forbs, grasses, and sedges present in each, were recorded. All stands were selected on the basis of relative homogeneity of vegetation, relief, soil conditions, and age since the last burn. Ecotones were avoided when possible.

During the summers of 1971 and 1972, 120 stands were intensively sampled. These stands were chosen from the reconnaissance plots as representative of the forest communities dominated by the following tree species: *Picea engelmannii*, *Abies lasiocarpa*, *Pinus flexilis*, *Pinus ponderosa*, *Pinus contorta*, and *Populus tremuloides*.

In each stand, a 49.2- by 82.0-foot (15- by 25-m) plot was laid out with the long dimension parallel to the contour. Each main plot then was subdivided into three 16.4- by 82.0-foot (5- by 25-m) subplots. Within each 4,036-square-foot (375-m^2) main plot, all trees taller than 3.28 feet (1 m) were measured at breast height and recorded by 0.328-foot (1-dm) classes. Trees less than 3.28 feet (1 m) tall were counted in two 3.28- by 82.0-foot (1- by 25-m) transects along the inner sides of the central subplot.

Canopy cover of the understory shrubs, forbs, and graminoids was estimated in fifty 8- by 20-inch (2- by 5-dm) microplots, placed systematically along the inner sides of the central subplot. Canopy coverage of each species was recorded as one of six coverage classes (1–5%, 6–25%, 26–50%, 51–75%, 76–95%, and 96–100%) (Daubenmire 1959). Also listed were those species not occurring in the 50 microplots but present within the 4,036-square-foot (375-m^2) main plot.

The serotinous cone habit of *Pinus contorta* in the Rocky Mountains is an important factor in regeneration success (Lotan and Perry 1983). To determine whether a plot contained serotinous or nonserotinous cones, crowns of 10 trees within the 4,036-square-foot (375-m^2) plot were observed with field glasses. The type of cone behavior observed over 90% of the tree was then indicated on the data sheet.

Table 1.—Size, elevational range, and principal forest vegetation grouped in four physiographic areas, Medicine Bow National Forest, Wyoming.

Location	Area (acres)	Elevation (feet)	Principal forest series
Snowy Range[1]	540,000 (218,624 ha)	8,000 to 12,013 (2,438 m to 3,662 m)	*Abies lasiocarpa, Picea engelmannii, Pinus contorta.*
Sierra Madre[2]	365,000 (147,773 ha)	6,500 to 11,044 (1,981 m to 3,354 m)	*Abies lasiocarpa, Picea engelmannii, Pinus contorta, Populus tremuloides.*
Pole Mountain	56,000 (22,672 ha)	8,200 to 9,053 (2,499 m to 2,759 m)	*Pinus ponderosa, Pinus flexilis.*
Laramie Peaks[3]	441,000 (178,542 ha)	6,300 to 10,272 (1,920 m to 3,131 m)	*Pinus ponderosa.*

[1] *519,000 acres (210,120 ha) are national forest land.*
[2] *339,000 acres (137,247 ha) are national forest land.*
[3] *179,000 acres (72,696 ha) are national forest land.*

ANALYSIS OF DATA

Tree-size class data were combined according to habitat type, and mean values for each size class in each habitat type were recorded (table A–1).

For each microplot examined, the midpoints of the canopy coverage classes were used to calculate average percent coverage for each shrub, graminoid, and forb species. Frequency also was determined for each species. Coverage and frequency data for all understory species plus site data are shown in appendix tables A–2 through A–10. Species coverage and selected stand characteristics then were transferred to an association table. Stands were arranged and rearranged to group stands with similar climax tree and understory floristic composition. Habitat type separation was based on a consideration of both overstory tree species and major shrubs, graminoids, and forbs, as measured by canopy cover (Daubenmire 1952, Daubenmire and Daubenmire 1968, Mueller-Dombois and Ellenberg 1974).

Nomenclature for undergrowth plants in this study follows Weber (1967, 1976), with some exceptions. Although plants were collected at various times during the growing season, some taxonomic difficulties persisted. Most of these resulted from hybridization among two or more species which have not been studied systematically to clarify the taxonomy. Other taxonomic difficulties related to lack of flowering specimens at the time of sampling. Where considerable variation made it impossible to determine species, generic names only were used. Undergrowth species that could not be positively identified were sent to the Forest Service Herbarium, Fort Collins, Colo., for verification.

ECOLOGIC TERMS AND CONCEPTS

Because terminology in ecology is not uniformly used or understood, the terms and concepts used in this paper are defined. Unless stated otherwise, all terms follow usage proposed by Daubenmire and Daubenmire (1968).

"Climax vegetation" is that which has attained a steady state with its environment; without disturbance, species of climax vegetation successfully maintain their population sizes within a stand. The following classification of climax vegetation was first proposed by Tansley (1935), with elaboration by Daubenmire (1968). "Climaxes" develop on habitats where recurring disturbance is not a factor influencing the structure or composition of the vegetation. "Climatic climax" vegetation develops on "normal" regional topography with deep, well-drained, well-developed soils. "Normal" topography in mountainous regions is necessarily different from that of plains regions. Where soils or topography exert sufficient influence to produce self-perpetuating vegetation distinct from the climatic climax, the terms "edaphic climax" and "topographic climax," respectively, are used to describe the steady-state vegetation. Where special topographic conditions also favor the development of edaphic conditions distinct from the "normal," the term "topo-edaphic climax" is often used in descriptions of the resulting steady-state vegetation. Where recurring disturbance, such as grazing or fire, exerts a predominant influence on the composition or structure of steady-state vegetation, the term "disclimax" is used. In the absence of the disturbing factor, or factors, it is possible the vegetation will revert to the primary climax.

Habitat type is the basic unit in classifying lands or sites based on potential (climax) natural vegetation. A habitat type represents, collectively, all parts of the landscape that support, or have the potential of supporting, the same climax plant association. Series is the next higher category of classification (Hoffman and Alexander 1976). For example, all habitat types with *Pinus ponderosa* as the potential climax dominant are grouped into the *Pinus ponderosa* series. The series is more than an artificial grouping of habitat types using the potential climax overstory dominant as the convenient thread

of continuity. There is an ecological basis for grouping habitat types into series. For example, *Pinus ponderosa* occupies sites warmer and drier than sites where *Populus tremuloides* is climax. Continuing higher into the mountains, *Pinus flexilis*, *Pinus contorta*, and *Picea engelmannii* and *Abies lasiocarpa* successively become the dominant species.

In the absence of adequate climatic data for the Medicine Bow National Forest, it is assumed that self-perpetuating populations of dominant trees are related to the macroclimate, whereas the undergrowth vegetation is related more to microclimate and soils. Stands in a series have the same general appearance whether they are in the Medicine Bow National Forest or in nearby forests of Colorado (Hess and Alexander 1986; Hoffman and Alexander 1980, 1983). Habitat types within a series are distinguished on the basis of undergrowth vegetation. For example, as explained later, *Populus tremuloides* is widely distributed in Wyoming as both a seral and a climax species. Where it is climax, several undergrowth unions may occur. The most luxuriant and widely distributed is the *Thalictrum fendleri* union. On some sites, a union formed by the single species *Carex geyeri* forms a conspicuous layer. Where *Carex geyeri* dominates the undergrowth, it forms another habitat type. Thus, *Populus tremuloides/Thalictrum fendleri* and *Populus tremuloides/Carex geyeri* are two distinct habitat types, even though *Carex geyeri* may be well-represented in both.

The Medicine Bow National Forest has been disturbed by fire, logging, and grazing for many years. Because of these disturbances, not all of the land area currently supports climax vegetation. It is possible that much of the area of a habitat type will never attain or regain climax status (Romme and Knight 1981). Nevertheless, it is important to consider land units in terms of their potential status, because assignment of a present stand to its potential climax habitat type results in "the most significant biogeographic classification of the land surface" (Daubenmire 1952). The practical value of using habitat type classifications to assemble management implications is beginning to be realized only in areas of tree productivity, disease and insect susceptibility, potential for producing browse, soil moisture depth, and tree regeneration (Arno and Pfister 1977; Daubenmire 1961, 1973; Layser 1974; Monsured 1984; Pfister 1972). The habitat type concept offers a useful approach to managing forest resources.

HABITAT TYPES

Forest vegetation in the Medicine Bow National Forest ranges from the *Pinus ponderosa*-dominated vegetation at the warmer, drier low elevations to the *Abies lasiocarpa-Picea engelmannii*-dominated vegetation at the cooler, more moist higher elevations.

PINUS PONDEROSA SERIES

The *Pinus ponderosa* series is largely restricted to Laramie Peaks. Only a few stands were observed in the Snowy Range and Pole Mountain areas; but no *P. ponderosa* stands were observed in the Sierra Madre area. This series occurs on deep, well-drained, sandy-, gravelly-, or clay-loam soils on a variety of aspects.

The *Pinus ponderosa* series was sampled on 13 plots representing three habitat types. Tree sizes ranged from seedlings to the ≥32-inch (≥8-dm) d.b.h. class. Tree populations and undergrowth data for *Pinus ponderosa* stands are shown in tables A–1 and A–2.

Pinus ponderosa/Arctostaphylos uva-ursi

Description

The *Pinus ponderosa/Arctostaphylos uva-ursi* habitat type, represented by five plots, only occupies small areas in any one place. This warm and dry habitat type occurs at elevations ranging from 6,300 to 8,300 feet (1,920 to 2,530 m) on all aspects and slopes, but is found most often on gentle, south-facing, middle slopes on shallow, well-drained soils derived from granites. The overstory is dominated by *P. ponderosa* in pure or nearly pure stands. *Populus tremuloides* may occur in the overstory or dominate seral stands. The undergrowth is dominated by *A. uva-ursi*, although its abundance varies considerably from place to place (fig. 2). *Berberis* (*Mahonia*) *repens*, *Rosa woodsii*, and *Symphoricarpos albus* are important associated shrubs. Major graminoids and forbs include *Hesperochloa kingii*, *Carex geyeri*, *Achillea lanulosa*, *Apocynum androsaemifolium*, *Arnica cordifolia*, *Cirsium canescens*, and *Lupinus argenteus*. This habitat type occurs in the Laramie Peaks and Snowy Range areas.

DeVelice et al. (1986) in northern New Mexico and southern Colorado, and Hoffman and Alexander[2] in the Black Hills, reported *P. ponderosa/A. uva-ursi* habitat types; but the associated undergrowth differs from the *P. ponderosa/A. uva-ursi* habitat type on the Medicine Bow National Forest.

Management Implications

Timber production potential of the *P. ponderosa/A. uva-ursi* habitat type is low and tree reproduction is likely to be difficult to obtain, especially in years of little precipitation. Forage production potential for livestock and big game is moderate to very low. Partial cutting is likely to increase the shrub and forb layers somewhat, improving diversity, but may not substantially increase forage production. The habitat type is most valuable to wildlife for cover when adjacent to grasslands. It also provides recreational opportunities. The *P. ponderosa/A. uva-ursi* habitat type has no potential for increasing water yield but does provide watershed protection.

[2]*Hoffman, George, and Robert R. Alexander. Forest vegetation of the Black Hills and Bearlodge Mountains of South Dakota and northeastern Wyoming: A habitat type classification. (Manuscript in preparation.)*

Pinus ponderosa/Carex rossii

Description

The *Pinus ponderosa/Carex rossii* habitat type was sampled with only two stands, but occurs in the Laramie Peaks, Pole Mountain, and Snowy Range areas. It occupies only small areas in any one place, however. This habitat type usually occurs on gentle to moderate middle to upper slopes on all aspects on moderately deep, excessively drained soils, usually derived from granites. Sites are dry but cooler than are associated with the *Pinus ponderosa/Arctostaphylos uva-ursi* habitat type. Stands sampled were at elevations between 6,400 and 6,500 feet (1,950 to 1,980 m). *P. ponderosa* dominates the overstory in relatively closed and usually pure stands. *C. rossii* dominates the sparse undergrowth (fig. 3). *Purshia tridentata* is the only associated shrub species that occurs frequently. Important graminoids, in addition to *C. rossii*, are *Hesperochloa kingii*, *Koeleria cristata*, and *Poa* spp. The major forbs include *Achillea lanulosa*, *Antennaria rosea*, *Cerastium arvense*, and *Sedum lanceolatum*. Hess and Alexander (1986) reported a *P. ponderosa/C. rossii* habitat type on the Roosevelt National Forest in Colorado with similar floristic composition; but it has not been reported elsewhere by investigators using standard habitat type classification methodology (Alexander 1985).

Management Implications

The potential for timber and water production is low to very low in this habitat type. Although *Hesperochloa kingii* and *Koeleria cristata* are highly palatable to cattle, the potential for increasing forage production is low, because precipitation is capable of maintaining only sparse forage. Cutting should be restricted to a light shelterwood to protect the site. *P. ponderosa* regeneration is likely to be difficult to obtain, especially on disturbed sites in dry years (Alexander 1986c). Although a variety of wildlife make occasional use of this habitat type, the potential for improving wildlife habitat is low to moderate. Cutting may improve forage production for big game but will reduce cover.

Figure 2.—*Pinus ponderosa/Arctostaphylos uva-ursi* habitat type. *Carex geyeri* is a common undergrowth associate below the *A. uva-ursi* layer.

Figure 3.—*Pinus ponderosa/Carex rossii* habitat type. *Juniperus communis* and *Yucca glauca* are in the right foreground.

Pinus ponderosa/Carex geyeri

Description

The *Pinus ponderosa/Carex geyeri* habitat type, represented by six plots, is the most common *P. ponderosa* habitat type on the Medicine Bow National Forest. It was sampled in all areas but the Sierra Madre. This moderately warm habitat type occurs on a variety of soil and physiographic conditions, at elevations ranging from 6,150 feet (1,875 m) to 8,500 feet (2,590 m). While the *P. ponderosa/C. geyeri* habitat type is the wettest in the *P. ponderosa* series, it is still confined to areas of low precipitation. The overstory is dominated by *P. ponderosa*, with *Populus tremuloides* occurring in the understory and as isolated small patches scattered throughout many stands. The undergrowth is dominated by *C. geyeri* (fig. 4). Shrubs frequently present in the undergrowth include *Arctostaphylos uva-ursi*, *Berberis* (*Mahonia*) *repens*, and *Juniperus communis*. The graminoids are well represented by *C. geyeri* and *Hesperochloa kingii*. The most frequently encountered forbs are *Achillea lanulosa*, *Antennaria rosea*, *Arnica cordifolia*, *Campanula rotundifolia*, *Cerastium arvense*, *Crepis acuminata*, and *Potentilla fissa*.

Komarkova[3] observed a *P. ponderosa/C. geyeri* plant community on the Gunnison National Forest in western Colorado, but did not recognize it as a habitat type. Mauk and Henderson (1984) reported a *P. ponderosa/C. geyeri* habitat type in northern Utah that has some floristic similarity to the Medicine Bow habitat type. This habitat type has not been reported elsewhere by investigators using standard habitat type classification methodology (Alexander 1985). However, there may be some confusion between this habitat type and the *Pinus ponderosa/Carex heliophila* habitat type; both *Carex*

[3]*Komarkova, Vera. Habitat types on selected parts of the Gunnison and Uncompahgre National Forests. (Final report.)*

species are rhizomatous and resemble each other in the vegetative stage. The *P. ponderosa/C. heliophila* habitat type has been reported in the Black Hills by Hoffman and Alexander.[2]

Management Implications

The potential for timber production is low. If stands are harvested, partial cutting that minimizes soil disturbance and maintains overhead shade is most appropriate (Alexander 1986c). Regeneration of *P. ponderosa* is likely to be difficult to obtain. Heavy cutting may either increase or decrease the amount of *C. geyeri*, depending upon the amount of ground disturbance. The potential for forage production for livestock is moderate, and moderate to high for big-game winter range. Heavy grazing by either livestock or big game may result in depletion of *C. geyeri* sod. The potential for increasing water yield is low; but the habitat type is valuable for watershed protection. It also has value for recreation, especially where grasslands alternate with this habitat type.

POPULUS TREMULOIDES SERIES

The *Populus tremuloides* series occurs throughout the Medicine Bow National Forest. It usually appears as small clonal patches scattered over the landscape at the lower fringes of the coniferous forests. On the southwestern slope of the Sierra Madre area, however, large, stable stands occur on cooler, more moist sites where porous, humic soils are found. This series occurs on a wide variety of topographic aspects and physiographic conditions.

There has been considerable discussion regarding the role of *P. tremuloides* as a climax and/or seral species in the Rockies; both assessments are correct, depending upon site conditions or historical factors (Mueggler 1985a). In some areas, *P. tremuloides* dominates sites where fires have destroyed coniferous forests. In time, conifers gradually replace *P. tremuloides*. Succession to coniferous forest is apparently slowed significantly by changes in soil resulting from site occupancy by the deciduous *Populus*. In other areas, *P. tremuloides* forests appear to be climax without evidence of conifer invasion. According to Mueggler (1976), complete conversion of *Populus* stands to coniferous climax forest may require more than 1,000 fire-free years. The origin of both seral and climax *P. tremuloides*-dominated forests may be the same—destruction of coniferous forest by repeated fires.

Figure 4.—*Pinus ponderosa/Carex geyeri* habitat type. *Hesperochloa kingii* is an important herbaceous associate of *C. geyeri*. *P. ponderosa* reproduction is abundant at this site.

Many *P. tremuloides* forests are even-aged, the trees having originated from sprouts after fire, logging, or other disturbances (Schier et al. 1985). Mueggler (1985a) suggested that in stands where older trees die naturally over a short time span, an even-aged replacement stand may develop. Other stands are uneven-aged, and sprouts apparently provide enough young trees to perpetuate the species indefinitely. Two-storied stands also are relatively common and can develop when surface fires burn quickly through mature stands without killing all trees, thereby stimulating sprouting.

The *P. tremuloides* series was sampled in 19 stands representing three habitat types. Tree sizes ranged from seedlings to the 28- to 32-inch (7- to 8-dm) d.b.h. class. Tree population and undergrowth data for the *P. tremuloides* stands are shown in tables A–1, A–3, and A–4.

Populus tremuloides/Calamagrostis rubescens

Description

The *Populus tremuloides/Calamagrostis rubescens* habitat type is restricted to the Sierra Madre and Snowy Range areas of the Medicine Bow National Forest. Stands sampled occurred on lower slopes and alluvial benches on moderate slopes on a variety of aspects at elevations ranging from 8,100 feet (2,470 m) to 8,600 feet (2,620 m). Soils usually are poorly drained and derived from sedimentary rocks. This habitat type, represented by five stands, is recognized by the dominance of *P. tremuloides* in the overstory and *C. rubescens* in the undergrowth (fig. 5). Other tree associates are inconspicuous. Shrubs are relatively unimportant. *C. rubescens*, *Carex geyeri*, *Elymus glaucus*, *Festuca occidentalis*, *Poa pratensis*, and *Poa reflexa* form a conspicuous graminoid layer. Important forbs are *Achillea lanulosa*, *Arnica cordifolia*, *Galium boreale*, *Taraxacum officinale*, *Vicia americana*, and *Viola nuttallii*.

This habitat type has not been identified previously in the central Rocky Mountains (Alexander 1985), but Mueggler and Campbell (1982) and Youngblood and Mueggler (1981) identified a *P. tremuloides/C. rubescens* community type in southeastern Idaho and western Wyoming. However, this community type is thought to be seral to a *Pseudotsuga menziesii/C. rubescens* habitat type.

Management Implications

Timber production in this warm and moderately moist habitat type is average to below average for the *Populus*

tremuloides series. While clearcutting and regenerating a new stand usually is the most effective timber harvesting method to perpetuate these stands, it should be avoided in stands where the water table is near the surface if regenerating a new stand is a management objective. This habitat type is moderate summer-fall range for big game and cattle. Forage production varies considerably—from 450 to 1,250 pounds per acre (500 to 1,400 kg/ha)—depending upon the percentage of graminoids in the undergrowth. The value of *C. rubescens* as livestock forage varies, because its palatability varies from year to year. Moreover, its nutritional value decreases as the season progresses. Overgrazing may deplete *C. rubescens* and expose soils difficult to revegetate. Annual precipitation, runoff, the potential for increasing streamflow, erosion, sedimentation, and mass movement are similar to the *P. tremuloides/Carex geyeri* habitat type. The *P. tremuloides/C. rubescens* habitat type has only fair scenic quality, because its color contrast is less favorable than mixed *Populus*-conifer stands.

Populus tremuloides/Carex geyeri

Description

The *Populus tremuloides/Carex geyeri* habitat type is widely distributed throughout the Medicine Bow National Forest, but reaches its maximum development in the Sierra Madre area on moderately deep to deep soils derived from a variety of parent materials. It occurs on a variety of slopes and aspects, at elevations ranging from 7,750 to 9,000 feet (2,360 to 2,745 m). The *P. tremuloides/C. geyeri* habitat type, represented by 11 stands, is recognized by the dominance of *P. tremuloides* in the overstory and *C. geyeri* in the understory (fig. 6). Other tree associates are inconspicuous to accidental. Shrubs include *Berberis* (*Mahonia*) *repens*, *Juniperus communis*, *Rosa woodsii*, *Symphoricarpos albus*, and *Symphoricarpos occidentalis*. In some stands, the shrub layer may be sparse. *Elymus glaucus* is the only graminoid, other than *C. geyeri*, that is of any significance.

Figure 5.—*Populus tremuloides/Calamagrostis rubescens* habitat type. Understory is a luxuriant mixture of herbaceous vegetation dominated by *C. rubescens*. Shrubs are usually sparse or absent.

Figure 6.—*Populus tremuloides/Carex geyeri* habitat type on a south slope. *Populus* occurs in a number of diameter classes in this dry habitat type.

Calamagrostis rubescens is usually absent. The most conspicuous forbs are *Achillea lanulosa*, *Arnica cordifolia*, *Galium boreale*, *Ligusticum filicinum*, *Lupinus argenteus*, *Osmorhiza depauperata*, *Oxytropis campestris*, *Thalictrum fendleri*, and *Viola nuttallii*.

This habitat type has been recognized in Colorado by Hess and Alexander (1986) on the Arapaho and Roosevelt National Forests, and by Hoffman and Alexander (1983) on the White River National Forest. Mauk and Henderson (1984) identified similar vegetation in the Uinta Mountains in Utah as a *P. tremuloides/C. geyeri* community type.

Management Implications

Timber productivity in this relatively cool and moderately moist habitat type is average to below average (Edminster et al. 1985). Clearcutting and regenerating a new stand is usually the most effective way to perpetuate these stands (Schier et al. 1985). In young *P. tremuloides* stands, thinning to GSLs 80 to 160, depending upon site index, will increase average stand diameter and reduce the time required to reach minimum merchantable size; but total volume production will not be greater at rotation age than in unthinned stands (Mowrer et al.).[4] Moreover, unless great care is taken to protect the residual stand, damage to these trees in thinning may cause them to become complete culls at the time of final harvest.

This habitat type is fair summer-fall range for big game and cattle. Forage production, which is less than in habitat types with forb-dominated understories, varies from 400 to 800 pounds per acre (450 to 900 kg/ha) depending upon range condition and management practices. Overgrazing may reduce *Carex* cover and expose soils that are difficult to revegetate. Annual precipitation varies from 20 to 30 inches (51 to 76 cm), with about 10 to 15 inches (25 to 38 m) of runoff. Potential for in-

[4]*Mowrer, H. Todd, Robert R. Alexander, Carleton B. Edminster, and Wayne D. Shepperd. Management of aspen in even-aged stands in the central Rocky Mountains. (Manuscript in preparation.)*

creasing streamflow is unknown. Erosion, sedimentation, and mass movement potentials are low. This habitat type has good scenic quality but less favorable color contrast than with mixed *Populus*-conifer stands. In open stands, the shrub understory provides both texture and variety in seasonal color. It also provides a pleasing ground color contrast in the fall when *Carex* remains green after other undergrowth vegetation has withered and dried.

Populus tremuloides/Thalictrum fendleri

Description

Populus tremuloides/Thalictrum fendleri habitat type is represented by three plots in the Sierra Madre and Snowy Range areas. Stands sampled occurred on lower to middle slopes with deep to very deep soils at elevations ranging from 8,000 to 8,700 feet (2,440 to 2,650 m). This relatively cool and moist habitat type usually is recognized by the dominance of *P. tremuloides* in the overstory and either *T. fendleri* or *Ligusticum filicinum* in the understory (fig. 7). In the Routt and White River National Forests, Hoffman and Alexander (1980, 1983) showed that the *Thalictrum fendleri* union is a rich mixture of primarily herbaceous species. The representation of the union at any particular site varies.

In some plots, *T. fendleri* may be absent or sparse, as seen in plots 80 and 258; but the union is identified by the presence of the aggregate group of species. Plot 80 was in a stand that was heavily grazed, and it appears that *Lathyrus leucanthus* increased with grazing at the expense of *Thalictrum fendleri* and *Ligusticum filicinum*. Plot 258 was poorly drained, and *Ligusticum filicinum* dominated the undergrowth. *Abies lasiocarpa* and *Pinus contorta* are the only tree associates of any significance in this habitat type, and their persistence beyond the seedling stage is not evident, possibly because of intense competition from undergrowth species and a relatively high water table. *Juniperus communis* and *Rosa woodsii* are the only shrubs of any importance, and they did not occur in all stands sampled. Important graminoids include *Bromus marginatus* and *Elymus glaucus*. Tall forbs form a dense undergrowth layer. These include *Delphinium occidentale*, *Galium boreale*, *Geranium richardsonii*, *Lathyrus leucanthus*, *Ligusticum filicinum*, *Osmorhiza depauperata*, *Thalictrum fendleri*, *Vicia americana*, and *Viola nuttallii*.

Figure 7.—*Populus tremuloides/Thalictrum fendleri* habitat type. *Ligusticum filicinum* dominates the undergrowth in this stand.

In Colorado, Hess and Alexander (1986), Hess and Wasser,[5] Hoffman and Alexander (1980, 1983) and Komarkova[3] identified a *Populus tremuloides/Thalictrum fendleri* habitat type on the Arapaho, Roosevelt, White River, Routt, and Gunnison National Forests that has many of the same characteristics. Mueggler and Campbell (1982) and Youngblood and Mueggler (1981) described similar vegetation in southeastern Idaho and western Wyoming as *P. tremuloides/T. fendleri* and *P. tremuloides/Ligusticum filicinum* community types. On the San Juan National Forest in southwestern Colorado, Johnston and Hendzel[6] recognized a *P. tremuloides/Ligusticum porteri* habitat type that is similar in undergrowth composition to the *P. tremuloides/T. fendleri* habitat type.

Management Implications

The *Populus tremuloides/Thalictrum fendleri* habitat type is the most productive for timber and forage in the *Populus* series (Edminster et al. 1985). Site quality for timber production ranges from average to high. Clearcutting in patches or small blocks and regenerating new stands is the most effective way to perpetuate this habitat type. Thinning in young *P. tremuloides* stands has the same advantages and disadvantages as in the *P. tremuloides/Carex geyeri* habitat type (Mowrer et al.).[4]

It is the best *Populus*-dominated habitat type for summer range for big game and for sheep. Although forage production under proper grazing management can be as high as 3,000 pounds per acre (3,360 kg/ha) for the first few years after clearcutting, sustained production under a *Populus* overstory is closer to 1,500 pounds per acre (1,680 kg/ha). This is the "classic" *Populus*-forb rangeland type that provides a significant amount of the forage produced on western ranges. Heavy livestock use, especially sheep, can reduce the cover of forbs. If *Ligusticum filicinum* is dominant, as may occur on sites with poor drainage, the undergrowth still has high potential for forage production under proper grazing management, because *L. filicinum* has high palatability for both cattle and sheep. However, if *Lathyrus leucanthus* becomes dominant as a result of heavy grazing, the undergrowth has less potential for forage production, because *Lathyrus* has low palatability.

The *P. tremuloides/T. fendleri* habitat type also provides habitat for numerous nongame animals; but the management implications for them are unknown. Vegetation of

[5]*Hess, Karl, and Clinton H. Wasser. Grassland, shrubland, and forestland habitat types on the White River-Arapaho National Forests. (Final report.)*

[6]*Johnston, Barry C., and Leonard Hendzel. Examples of aspen treatment, succession, and management in western Colorado. (Report.) Rocky Mountain Region, Denver, Colo.*

this habitat type has the most visually appealing foreground of all *Populus*-dominated habitat types because of the usually wide spacing with large tree diameters and the abundance of wildflowers in the undergrowth. Soils are well developed, and erosion usually is not a problem, except on deteriorated ranges. In some situations, potential for soil mass movement appears to be high, especially on steep, poorly-drained slopes or if the overstory is removed in large clearcut blocks. Annual precipitation is 25 to 30 inches (64 to 76 cm), with about one-half becoming runoff. Potential for increasing streamflow under management is unknown.

PINUS FLEXILIS SERIES

The *Pinus flexilis* series occurs in all four areas of the Medicine Bow National Forest; but the most extensive stands occur on Pole Mountain. This series occurs as a topographic climax in open stands on dry, rocky ridgetops and exposed, southwestern aspects. All plots in this series were located west of the Continental Divide.

The *Pinus flexilis* series was sampled in 10 plots representing two habitat types. Tree sizes ranged from seedlings to the 28- to 32-inch (7- to 8-dm) d.b.h. class. Tree population and undergrowth data for *Pinus flexilis* stands are shown in tables A–1 and A–5.

Pinus flexilis/Hesperochloa kingii

Description

The *Pinus flexilis/Hesperochloa kingii* habitat type was sampled in eight stands in the Pole Mountain, Sierra Madre, and Snowy Range areas. This habitat type was sampled at elevations ranging from 8,400 feet (2,560 m) to 9,300 feet (2,830 m), in small, widely-distributed stands, on gentle to moderate slopes bordered by *Pinus contorta*- or *Abies lasiocarpa*-dominated vegetation. Soils are moderately shallow, coarse-textured, and well- to very well-drained. This habitat type is recognized by the dominance of open-grown *P. flexilis* in the overstory and *H. kingii* in the undergrowth (fig. 8). Other tree species are usually absent. The undergrowth is usually sparse and low. *Artemisia tridentata*, *Juniperus communis*, and *Ribes cereum* are the most common shrubs, but their coverage is low. The most important graminoids are *H. kingii*, *Agropyron spicatum*, *Koeleria cristata*, and *Poa cusicki*; important forbs are usually *Antennaria rosea*, *Arenaria congesta*, *Erigeron flagellaris*, *Potentilla fissa*, and *Sedum lanceolatum*. Species diversity varies considerably from stand to stand.

Figure 8.—*Pinus flexilis/Hesperochloa kingii* habitat type. *Pinus flexilis* is the only tree present. *H. kingii* and *Artemisia tridentata* dominate the undergrowth on this dry, southwest aspect.

A *P. flexilis/H. kingii* habitat type has been reported in northwestern Wyoming by Steele et al. (1983), but the undergrowth is somewhat different from the *P. flexilis/H. kingii* habitat type on the Medicine Bow National Forest. It also occurs in east-central Idaho (Steele et al. 1981).

Management Implications

Timber production potential for this moderately warm and relatively dry habitat type is very low. Under natural conditions, reproduction is sporadic and slow growing; much of the seed produced is consumed by small animals or birds. The remaining seed usually germinate in clusters, but ordinarily only one seedling survives to maturity. Fire is also a threat to reproductive success. Forage production for livestock is moderately high; but suitability for use depends upon the proximity of grasslands or *Artemisia*-dominated shrublands. *A. tridentata* usually increases on heavily grazed lands. The *P. flexilis/H. kingii* habitat type may be used by big game as winter range where it has moderate potential. Open-grown stands on ridges have moderately high potential for bighorn sheep transitional range. The potential for water production is low; but the habitat type provides watershed protection. Removal of cover on steep slopes usually results in rill erosion.

Pinus flexilis/Juniperus communis

Description

Pinus flexilis/Juniperus communis is a minor habitat type, sampled in only two stands in the Snowy Range area, at elevations ranging from 9,550 to 9,800 feet (2,910 to 2,985 m). It occurs on middle to upper convex, gentle to moderate slopes on nonnortherly aspects. Soils are shallow and well-drained. The overstory is dominated by open-grown *P. flexilis*. Other tree species are absent or occur only occasionally. The understory is dominated by *J. communis*, the only shrub with high constancy (fig. 9). The sparse undergrowth consists of a number of graminoids and forbs; the most important are *Carex geyeri*, *Hesperochloa kingii*, *Antennaria rosea*, *Erigeron flagellaris*, and *Lupinus argenteus*.

Hess and Alexander (1986) and Hoffman and Alexander (1980) reported a *Pinus flexilis/Juniperus communis* habitat type on the Arapaho, Roosevelt, and Routt National Forests, adjacent to and south of the Medicine Bow National Forest, with similar floristic composition. Hoffman and Alexander (1976, 1983) did not report a *P. flex-*

ilis/J. communis habitat type in either the Bighorn Mountains of north-central Wyoming or on the White River National Forest in western Colorado. Pfister et al. (1977), Steele et al. (1981), and Steele et al. (1983) described a *Pinus flexilis/Juniperus communis* habitat type east of the Continental Divide in Montana, in central Idaho, and in northwestern Wyoming, respectively. However, *P. flexilis/J. communis* stands on the Medicine Bow National Forest show little floristic similarity to those in Montana, Idaho, and northwestern Wyoming.

Management Implications

This moderately warm and dry habitat type has very low productivity for timber production. Forage value for livestock is low but is moderate to high for big game, with some evidence of use by deer in the spring and fall. Potential for bighorn sheep transitional range may be high in open-grown stands on ridgetops. Overstory trees may provide cover for wildlife. The *P. flexilis* seeds are food for birds and small mammals. High soil surface temperatures and low soil moisture may impede regeneration or revegetation of disturbed areas. There is little or no potential for increasing streamflow, but the habitat type provides watershed protection.

PINUS CONTORTA SERIES

The *Pinus contorta* series is a major forest type throughout the Medicine Bow National Forest in the upper montane and lower subalpine forest zones. As is the case elsewhere in the Rocky Mountains, its occurrence in large stands usually is attributed to widespread and repeated fires. The most extensive mature stands of *Pinus contorta* are in the Snowy Range and Sierra Madre areas; fewer and less mature stands are located in the Pole Mountain and Laramie Peaks areas. The series occurs over a wide range of soils, but seems to thrive best on moderately acid sands or gravelly loams that are well-drained to excessively well-drained, compared to nearby sites dominated by *Abies lasiocarpa* and *Picea engelmannii*.

Figure 9.—*Pinus flexilis/Juniperus communis* habitat type. Trees are short and widely spaced. Undergrowth is depauperate.

There is less agreement on its successional status. Many ecologists and foresters consider *P. contorta* a seral species, which, in the absence of fire, would be replaced by forests dominated by *Picea engelmannii* and *Abies lasiocarpa* at higher elevations, and *Pseudotsuga menziesii* at lower elevations (Clements 1910, Daubenmire 1943, Mason 1915). More recently, investigators have concluded that *Pinus contorta* is climax, or a long-lived subclimax species in certain topo-edaphic situations. Moir (1969) reported it to be climax within the upper montane zone of the Front Range of Colorado. Hoffman and Alexander (1976, 1980) described climax *P. contorta* forests in the Bighorn Mountains, Wyoming, occurring on soils derived from granites, and on the Routt National Forest. Hess and Alexander (1986), Hess and Wasser,[5] and Komarkova[3] also described climax *P. contorta* stands on the Arapaho, Roosevelt, White River, and Gunnison National Forests, respectively. Climax *P. contorta* forests are described in the Wind River and Absaroka Mountains, western Wyoming, by Steele et al. (1983), and Pfister et al. (1977) and Steele et al. (1981) reported apparently stable *Pinus contorta* forests in Montana and Idaho.

In the Medicine Bow National Forest, *P. contorta* is rare in *Pinus ponderosa* or *Populus tremuloides* forests; but it is a common seral species in *Picea engelmannii-Abies lasiocarpa* forests. Seral *P. contorta* is more likely to be even-aged and bear a high proportion of serotinous cones. Where *P. contorta* is the dominant self-reproducing species, it normally exhibits a population structure of several age classes, and has little or no competition from its common associates. Typically, *P. contorta* grows faster and produces larger trees where it is seral to *Abies* and *Picea* than where it is climax. Climax or stable uneven-aged *P. contorta* stands are more likely to contain a higher proportion of trees bearing nonserotinous cones (Lotan 1975). Moreover, they usually occur at higher elevations on the Medicine Bow National Forest.

In some areas, especially on relatively dry sites, *P. contorta* forms dense dog-hair stands with little undergrowth. In these situations, *P. contorta* may be a seral species that will occupy the site for hundreds of years, either because there is no seed source of climax species available for reinvasion, or site and/or stand density restricts the establishment of climax species.

This series is represented by 29 stands and five habitat types. Tree sizes ranged from seedlings to the ≥32-inch (≥8-dm) d.b.h. class. Tree population and undergrowth data for *Pinus contorta* stands are shown in tables A–1, A–6, A–7, and A–8.

Pinus contorta/Juniperus communis

Description

This habitat type, represented by four stands, was sampled in the Snowy Range and Pole Mountain areas. This warm and dry habitat type occurred at elevations ranging from 8,200 to 8,700 feet (2,500 to 2,650 m). It is recognized by the dominance and reproductive success

of *Pinus contorta*, usually in pure stands, but occasionally with *Populus tremuloides* or *Pinus flexilis* in the understory. *Juniperus communis* dominates a depauperate undergrowth (fig. 10). *J. communis* and *Rosa woodsii* are the only frequently occurring shrubs, but their coverage is low. The herbaceous undergrowth includes *Carex rossii*, *Poa nervosa*, *Arnica cordifolia*, *Campanula rotundifolia*, and *Solidago decumbens*.

Hess and Alexander (1986), and Komarkova[3] described a *P. contorta/J. communis* habitat type on the Arapaho, Roosevelt, and Gunnison National Forests. In northwestern Wyoming and southeastern Idaho, Steele et al. (1983), and in northern Utah, Mauk and Henderson (1984), reported a *P. contorta/J. communis* community type that is similar to the habitat type described here except that its successional status is unclear. A similar habitat type was not described on the Routt National Forest (Hoffman and Alexander 1980) or White River National Forest (Hoffman and Alexander 1983).

Management Implications

The *Pinus contorta/Juniperus communis* habitat type has the lowest timber production potential of the *P. contorta* series. Regeneration is likely to be difficult to obtain in this dry habitat type. Clearcutting or shelterwood cutting can be used in sawlog-sized stands regardless of cone habit. Scarification is likely to be essential for natural regeneration success. On south slopes and in tension zones, a long regeneration period usually follows clearcutting because of limited soil moisture. In those situations, a standard shelterwood system is more likely to result in regeneration success, but a shelterwood should not be used in dwarf mistletoe infected stands. On other aspects, clearcutting is usually successful, but can result in either too much or too little reproduction, depending on the cone habitat, amount of seed available, and slash disposal treatment (Alexander 1974, 1986b).

If a clearcut option is used in stands with nonserotinous cones, openings should be limited to small [3- to 5-acre (1- to 2-ha)] patches or narrow [400-foot (122-m) wide] strips where natural regeneration is desired. Large-clearcut openings will require fill-in planting. In stands with serotinous cones, clearcut openings up to 40 acres (16 ha) may be used if the stand is heavily infected with dwarf mistletoe or infested with mountain pine beetles. Care must be used in slash disposal in these stands so that the seed source is not destroyed. Group selection cutting is a possibility in stands with irregular structure; but individual-tree selection cutting is generally appropriate only in recreation areas when the objective is to create multistoried stands.

In young *P. contorta* pole stands, thinning is needed to reduce basal area and improve soil moisture conditions. Growing stock levels (GSL) of 80 and 120 are most appropriate for timber production (Alexander and Edminster 1981). Forage production usually is increased slightly for a short time following clearcutting, but the potential for increasing forage production for either livestock or big game is small in this habitat type. Natural runoff in the *P. contorta/J. communis* habitat type is at least 8 inches (20 cm) annually. Much of the precipitation falls as snow. Streamflow can be increased by clearcutting in small patches, or group shelterwood and group selection when the openings are near the maximum size [2 acres (0.8 ha)].

Figure 10.—*Pinus contorta/Juniperus communis* habitat type. Undergrowth is sparse in this dry habitat type.

Pinus contorta/Carex rossii

Description

The *Pinus contorta/Carex rossii* habitat type is represented by five stands sampled in the Snowy Range area. Stands in this moderately cold and dry habitat type, found at elevations ranging from 8,400 feet (2,560 m) to 9,500 feet (2,895 m), tend to be more open and patchy than in the wetter *Pinus contorta/Carex geyeri* habitat type. This habitat type occurs on gentle to moderate middle to lower slopes, with moderately deep and well-drained soils. The *P. contorta/C. rossii* habitat type is recognized by the overstory dominance and reproductive success of *P. contorta*, and the rare occurrence of other tree species. *C. rossii* dominates the undergrowth, but only because other species usually are sparse (fig. 11).

Figure 11.—*Pinus contorta/Carex rossii* habitat type. *C. rossii* dominates the depauperate undergrowth. There is no indication of replacement of *P. contorta*.

Shrubs may include *Arctostaphylos uva-ursi*, *Berberis (Mahonia) repens*, *Vaccinium caespitosum*, and *Vaccinium scoparium*, but the shrub layer is often absent. *C. rossii* is the only graminoid of any consistency. The depauperate forb layer includes *Arnica cordifolia*, *Lupinus argenteus*, and *Solidago decumbens*. In one plot (150), the coverage and frequency of *Arctostaphylos uva-ursi* is much higher than in the other four plots. While this suggests that these stands may be somewhat different, further sampling will be required before a *Pinus contorta/Arctostaphylos uva-ursi* habitat type can be confirmed on the Medicine Bow National Forest.

The *P. contorta/C. rossii* habitat type has not been reported in Colorado by investigators using standard habitat type classification methodology (Alexander 1985) or in the Bighorn Mountains of north-central Wyoming (Hoffman and Alexander 1976). A *P. contorta/C. rossii* habitat type was described by Mauk and Henderson (1984) in northern Utah, and a *P. contorta/C. rossii* community type with similar floristic composition was reported in northwestern Wyoming by Steele et al. (1983). The successional status of *P. contorta* is uncertain in this community type, however.

Management Implications

Timber productivity in this habitat type is average to below average for *P. contorta* (Alexander 1966). Clearcutting in small openings or shelterwood is recommended for most stands (Alexander 1986b). However, natural regeneration may be difficult to obtain, especially after clearcutting, because sites supporting this habitat type are dry and *C. rossii* competes severely with seedlings. Large openings are not recommended under any circumstance. A shelterwood alternative has the advantage of protecting the site and reducing undergrowth competition. Stands in the *P. contorta/C. rossii* habitat type usually are not highly susceptible to mountain pine beetle. Forage production is low to very low, and there is little potential for any significant increase. Wildlife habitat is poor, with little potential for improvement. Natural runoff in the *P. contorta/C. rossii* habitat type is at least 8 inches (20 cm) annually; but the potential for increasing streamflow by timber harvest is not known. Potential for increasing erosion by timber harvest and roadbuilding is moderately high.

Pinus contorta/Shepherdia canadensis

Description

Pinus contorta/Shepherdia canadensis is a major habitat type in the central Rocky Mountains (Alexander 1985), but was sampled in only two stands in the Medicine Bow National Forest, at elevations ranging from 7,900 feet (2,375 m) to 8,700 feet (2,650 m). However, observation indicates that this moderately warm and dry habitat has much wider distribution on the Medicine Bow National Forest on gentle lower slopes and benches, with shallow to moderately deep and well-drained soils. The stands

Figure 12.—*Pinus contorta/Shepherdia canadensis* habitat type. *Juniperus communis* is present in the undergrowth.

sampled were located in the Sierra Madre and Snowy Ranges. *P. contorta/S. canadensis* habitat type usually occurs in close proximity to the *Pinus contorta/Carex geyeri* habitat type. In the stands sampled, the constant presence and reproductive success of *P. contorta*, the absence of any significant reproduction of other coniferous tree species, and the understory dominance of *S. canadensis* are the diagnostic features of this habitat type (fig. 12). In addition to *S. canadensis*, other shrubs with frequent occurrence are *Berberis (Mahonia) repens*, *Pyrola* spp., and *Rosa woodsii*. The depauperate herbaceous layer includes *Carex geyeri*, *Arnica cordifolia*, *Epilobium angustifolium*, *Lupinus argenteus*, and *Sedum lanceolatum*.

Hoffman and Alexander (1980) on the Routt National Forest, Hess and Wasser[5] on the White River National Forest, and Hess and Alexander (1986) on the Arapaho and Roosevelt National Forests reported a *P. contorta/S. canadensis* habitat type, which closely resembles the habitat type described here. However, Hoffman and Alexander (1983) did not report a *P. contorta/S. canadensis* habitat type on the White River National Forest, nor did Komarkova[3] observe one on the Gunnison National Forest. Hoffman and Alexander (1976) described an *Abies lasiocarpa/S. canadensis* habitat type on north slopes in the Bighorn Mountains, which was characterized by the presence of *V. scoparium* beneath the *S. canadensis*-dominated undergrowth. Steele et al. (1983) reported a *P. contorta/Shepherdia canadensis* community type in southeastern Idaho and northwestern Wyoming.

Management Implications

The *Pinus contorta/Shepherdia canadensis* habitat type is reasonably productive for timber, even though site indexes are likely to be average to below average (Alexander 1966). Even-aged management, under either a clearcutting or shelterwood cutting alternative, is recommended for most stands (Alexander 1986b). A standard shelterwood alternative has the advantages of better meeting wildlife cover and visual management requirements, while at the same time providing shade

needed to conserve soil moisture and help control overstocking. It also provides some control over dwarf mistletoe, although clearcutting is a more effective silvicultural control. Clearcutting can result in either too much or too little reproduction, depending on the cone habit, amount of seed available, climatic factors, and slash disposal treatments (Alexander 1974, 1986b).

If a clearcut option is used in stands with nonserotinous cones, openings should be 3- to 5-acre (1- to 2-ha) patches or narrow 400-foot (122-m) wide strips where natural regeneration is desired. Large clearcut openings will require fill-in planting. In stands with serotinous cones, clearcut openings up to 40 acres (16 ha) may be used if the stand is heavily infected with dwarf mistletoe or infested with mountain pine beetles. However, smaller openings, 5 to 20 acres (2 to 8 ha), better meet the objectives of multiresource management. Care must be used in slash disposal so that the seed source is not destroyed.

Uneven-aged management under individual-tree or group selection cutting can reduce stand susceptibility to mountain pine beetles by removing the most susceptible host trees. Group selection cutting is a possibility in stands with irregular structure; but individual-tree selection in stands not attacked by mountain pine beetles is generally appropriate only in recreation areas. Growth will be substantially reduced, however, with either uneven-aged cutting method.

In young *P. contorta* pole stands, thinning is needed to reduce basal area and improve soil moisture conditions. Growing stock levels of 120 to 160 are most appropriate for timber production (Alexander and Edminster 1981). Forage production is usually increased for a short time after clearcutting; but the potential for increasing forage production for either livestock or big game is small in this habitat type.

Natural runoff in the *P. contorta/Shepherdia canadensis* habitat type is 10 to 12 inches (25 to 30 cm) annually. Much of the precipitation falls as snow. Streamflow can be increased substantially by clearcutting about one-third of the area in small [3- to 5-acre (1- to 2-ha)] patches interspersed with uncut timber (Leaf 1975, Leaf and Alexander 1975, Troendle 1983, Troendle and King 1985). If larger openings are cut, slash should be left in place to create surface roughness needed to retain the snowpack. Streamflow can also be increased by partial cutting on north slopes; but runoff will be less than with clearcutting (Troendle and Meiman 1984). Group shelterwood and group selection cutting can be nearly as favorable for water production as clearcutting if the openings are near the maximum size.

Pinus contorta/Carex geyeri

Description

In the original analyses of the Medicine Bow National Forest data, Wirsing (1973) and Wirsing and Alexander (1975) recognized the *Pinus contorta/Carex geyeri* plant association as a community type seral to an *Abies lasiocarpa/Carex geyeri* habitat type. Because of the tree population structure of *Pinus contorta* and the lack of evidence of replacement by *Abies lasiocarpa* and *Picea engelmannii*, this plant association is recognized as a habitat type in certain topo-edaphic situations.

Figure 13.—*Pinus contorta/Carex geyeri* habitat type. *Pinus* has succeeded *Populus tremuloides* in this stand.

The *Pinus contorta/Carex geyeri* habitat type occurs at the lowest elevations [7,700 feet (2,345 m)] of stands sampled in the *Pinus contorta* series. It also occurs at elevations as high as 9,700 feet (2,955 m). Soils are moderately deep and moderately well-drained, and have formed in place. This moderately warm and dry habitat type, represented by eight stands, is found throughout the Medicine Bow National Forest, although no stands were sampled on Pole Mountain. It is recognized by the overstory dominance and reproductive success of *Pinus contorta*, and the undergrowth dominance of *Carex geyeri* (fig. 13).

In seven of the stands sampled, the shrub layer is poorly developed with *Berberis (Mahonia) repens*, *Juniperus communis*, and *Rosa woodsii* the only species with any constancy. Herbaceous vegetation dominates the undergrowth; *C. geyeri* is the only important graminoid. Important forbs include *Arnica cordifolia*, *Lupinus argenteus*, and *Oxytropis campestris*. In one stand (270) included in this habitat type, the undergrowth is dominated by *Vaccinium caespitosum* and *Calamagrostis rubescens*. This suggests the possibility that a *Pinus contorta/Calamagrostis rubescens* habitat type may occur on the Medicine Bow National Forest, but it cannot be confirmed without additional sampling.

A *Pinus contorta/Carex geyeri* habitat type has been reported in Colorado on the Arapaho and Roosevelt National Forests by Hess and Alexander (1986), on the White River National Forest by Hess and Wasser,[5] and on the Gunnison National Forest by Komarkova.[3] However, Hoffman and Alexander (1976, 1980, 1983) did not identify this habitat type on either the Routt or White River National Forests in Colorado, or in the Bighorn Mountains of north-central Wyoming; but *Pinus contorta* is a long-lived seral member of the *Abies lasiocarpa/Carex geyeri* habitat type on these forests. In northwestern Wyoming and central Idaho, Steele et al. (1981, 1983) reported a *P. contorta/C. geyeri* community type that has similar characteristics, although there are differences in floristic composition.

Management Implications

Timber productivity in this habitat type is average to below average. Site indexes are likely to be below average (Alexander 1966). Even-aged management, under either a clearcutting or shelterwood alternative, is recommended for most stands (Alexander 1986b). However, natural regeneration is difficult to obtain after clearcutting, because the *C. geyeri*-dominated undergrowth competes intensively with seedlings. A shelterwood cutting alternative has the advantage of better control over undergrowth development and may better meet wildlife cover and visual requirements.

Although most stands in the *P. contorta/C. geyeri* habitat type bear serotinous cones, clearcutting in large openings is not recommended because of the competition between seedlings and *C. geyeri*. A better option would be to use the opening size recommended for stands with nonserotinous cones. Large openings have an advantage of reducing losses in stands infected with dwarf mistletoe or susceptible to attack by mountain pine beetle; but the manager must accept the likelihood that it will take a long time to regenerate these stands. Care must be used in slash disposal and seedbed preparation so that the seed source is not destroyed.

Uneven-aged management under individual-tree or group selection cutting can reduce stand susceptibility to mountain pine beetles by removing the most susceptible host trees. Group selection cutting is a possibility in stands with irregular structure, but individual-tree selection in stands not attacked by mountain pine beetles is generally appropriate only in recreation areas. Growth will be substantially reduced, however, with either uneven-aged cutting method.

In young *P. contorta* pole stands, thinning is needed to reduce basal area and improve growth and soil moisture conditions. Growing stock levels (GSL) of 100 to 120 are most appropriate for timber production (Alexander and Edminster 1981). Forage production is fair to poor and not likely to be improved by cutting. Wildlife habitat is poor, and the potential for increasing it is not very good. Big game use is limited, and nongame bird and small mammal populations are sparse. Stands often are dominated solely by *P. contorta* and *C. geyeri*.

Natural runoff in the *P. contorta/C. geyeri* habitat type is at least 10 inches (25 cm) annually. Much of the precipitation falls as snow. Management to increase streamflow is the same as for the *P. contorta/Shepherdia canadensis* habitat type.

Pinus contorta/Vaccinium scoparium

Description

In the original analyses of the Medicine Bow data, Wirsing (1973) and Wirsing and Alexander (1975) recognized the *Pinus contorta/Vaccinium scoparium* plant association as a community type seral to the *Abies lasiocarpa/Vaccinium scoparium* habitat type. Because of the tree population structure of *Pinus contorta* and the lack of evidence of replacement by *Abies lasiocarpa* and *Picea engelmannii*, especially on dry sites, this plant association is recognized as a habitat type. The *P. contorta/V. scoparium* habitat type, found at elevations ranging from 8,800 to 9,800 feet (2,680 to 2,985 m), extends to the upper altitudinal limits of the *P. contorta* series. This habitat type is found on the coldest sites in the *P. contorta* series. Soils are shallow and very well-drained, often derived from granites. It occurs throughout the Medicine Bow National Forest, but was sampled only in the Sierra Madre and Snowy Ranges.

Figure 14.—*Pinus contorta/Vaccinium scoparium* habitat type. The sparse undergrowth indicates that this habitat type is more xeric than the associated *Abies lasiocarpa/Vaccinium scoparium* habitat type.

This habitat type, represented by 10 plots, is recognized by overstory dominance and reproductive success of *P. contorta*. The presence of an occasional *Abies lasiocarpa* and *Picea engelmannii* is not sufficient to indicate replacement of *P. contorta*. The well-drained soils are too dry to support *Abies* and *Picea* reproduction. The depauperate undergrowth is dominated by *Vaccinium scoparium* (fig. 14). Associated shrubs of high constancy are *Berberis* (*Mahonia*) *repens* and *Juniperus communis*. Herbaceous vegetation, inconspicuous and poorly represented, includes *Carex rossii*, *Arnica cordifolia*, *Epilobium angustifolium*, *Lupinus argenteus*, and *Solidago decumbens*.

A *P. contorta/V. scoparium* habitat type was reported in the Bighorn Mountains by Hoffman and Alexander (1976), on the Arapaho and Roosevelt National Forests by Hess and Alexander (1986), and on the Gunnison National Forest by Komarkova.[3] Although Hoffman and Alexander (1980, 1983) did not report this habitat type on the Routt National Forest or on the White River National Forest, they described an *Abies lasiocarpa/Vaccinium scoparium* habitat type that had *Pinus contorta* as a long-lived seral. A similar community type was reported in Montana by Pfister et al. (1977), in central Idaho by Steele et al. (1981), in northwestern Wyoming by Steele et al. (1983), in northern Idaho by Cooper et al.,[7] and in the Uinta Mountains, Utah, by Mauk and Henderson (1984).

[7]*Cooper, Steven, Kenneth Neiman, and Robert Steele. Forest habitat types of northern Idaho. (Manuscript in preparation.)*

Management Implications

Site indexes and timber productivity are the highest in the *P. contorta* series. Even-aged management under either a clearcutting or shelterwood cutting alternative is recommended for most stands (Alexander 1986b). A shelterwood system has the advantages of meeting wildlife cover and visual management requirements, while at the same time providing shade needed to conserve soil moisture and control overstocking. It also provides some control over dwarf mistletoe, although clearcutting is a more effective silvicultural control. Uneven-aged management under individual-tree or group selection cutting can reduce stand susceptibility to mountain pine beetles by removing the most susceptible host trees. Growth will be substantially reduced, however. Treatment of stands in relation to cone serotiny is the same as in the *P. contorta/Shepherdia canadensis* habitat type.

Poletimber stands in this habitat type have better spacing and crown class differentiation. Thinning to growing stock levels of 120 to 160 is most appropriate for individual tree and stand growth (Alexander and Edminster 1981).

The *P. contorta/V. scoparium* habitat type is high-elevation summer range for wildlife. Forage production is moderate to fair for big game, but can increase substantially for short periods of time following clearcutting. Forage production for livestock can be increased to 500 pounds per acre (560 kg/ha) by clearcutting, provided that there is a good response by herbaceous vegetation, but sites are cold, with a short growing season. Natural runoff in the *P. contorta/V. scoparium* habitat type is 12 to 15 inches (30 to 38 cm). Management to increase water yield is the same as for the *P. contorta/Shepherdia canadensis* habitat type.

ABIES LASIOCARPA SERIES

The *Abies lasiocarpa* series represents a major forest type throughout the Medicine Bow National Forest. Occupying the highest and coldest coniferous forest zone, these forests—dominated by *Abies lasiocarpa* and *Picea engelmannii*—are usually referred to as subalpine forests and are widespread throughout much of the Rocky Mountains. The forests are of considerable importance. On the Medicine Bow National Forest, these forests are found on all aspects at elevations of 8,000 to 11,500 feet (2,438 to 3,505 m), a span of 3,000 feet (914 m). The lower elevational limits of *Abies lasiocarpa*-dominated forests and the upper elevational limits of the *Pinus contorta*-dominated forests overlap, although aspect and soils play some part in the forest distribution.

The habitat types described in this series are all named for *Abies lasiocarpa* as the climax dominant to be consistent with usage elsewhere (Daubenmire and Daubenmire 1968; Hess and Alexander 1986; Hoffman and Alexander 1976, 1980, 1983; Mauk and Henderson 1984; Pfister et al. 1977; Steele et al. 1981, 1983). On the Medicine Bow National Forest, *Picea engelmannii* is a co-climax dominant, with little evidence that it will ever be completely replaced by *Abies lasiocarpa*. Young *A. lasiocarpa* usually outnumber the young *Picea engelmannii*, because *A. lasiocarpa* is more tolerant and reproduces by layering and from seed, whereas *Picea engelmannii* reproduces almost entirely from seed. Because *P. engelmannii* live longer, they are nearly always the largest trees in the stand. The only exception occurs in stands where *P. engelmannii* has been severely attacked by the spruce beetle (*Dendroctonus rufipennis* Kirby) (Schmid and Hinds 1974).

In most stands, *Pinus contorta* and/or *Populus tremuloides* are present as seral species. After disturbance, *P. tremuloides* may establish initially to be succeeded by *Pinus contorta* which, in turn, is replaced by *Abies lasiocarpa* and *Picea engelmannii*. *A. lasiocarpa* and *P. engelmannii* can reestablish immediately with or without *P. contorta* and/or *P. tremuloides*, depending on the topographic situation, the type of disturbance, and the availability of coniferous tree seed or the sprouting capacity of *Populus*.

This series is represented by 49 stands and three habitat types. Tree sizes ranged from seedlings to the ≥32-inch (≥8-dm) d.b.h. class. Tree population and undergrowth data for *Abies lasiocarpa* stands are shown in tables A–1, A–9, and A–10.

Abies lasiocarpa/Carex geyeri

Description

This habitat type is usually found at lower elevations than the *Abies lasiocarpa/Vaccinium scoparium* habitat type on deeper, less well-drained soils. The *Abies lasiocarpa/Carex geyeri* habitat type, represented by four stands, was observed throughout the Medicine Bow National Forest but was sampled only in the Sierra Madre and Snowy Ranges, at a restricted elevational range of 8,500 to 8,600 feet (2,590 to 2,650 m). It is distinguished by the dominance of *Carex geyeri* in the undergrowth, and the near absence of *Vaccinium scoparium* and *Vaccinium myrtillus* (fig. 15). The overstory dominants are *Abies lasiocarpa* and *Picea engelmannii*. *Pinus contorta* and *Populus tremuloides* are common seral species, and *P. tremuloides* may form large, conspicuous seral stands. However, neither seral species shows any evidence of long-term self-perpetuation. Important undergrowth species, in addition to *Carex geyeri*, are *Juniperus communis*, *Rosa woodsii*, *Arnica cordifolia*, *Erigeron peregrinus*, and *Galium boreale*.

This habitat type was described in the Routt National Forest by Hoffman and Alexander (1980), in the White River National Forest by Hoffman and Alexander (1983) and Hess and Wasser,[5] in the Gunnison National Forest by Komarkova,[3] and in the Arapaho and Roosevelt National Forests by Hess and Alexander (1986). This habitat type also has been reported in western Wyoming in Yellowstone National Park and the Teton National Forest (Steele et al. 1983), and in the mountains of central and southern Utah (Youngblood and Mauk 1985). In Montana, an *Abies lasiocarpa/Carex geyeri* habitat type is a minor habitat type, occurring on cold, dry sites (Pfister

et al. 1977) but is common in central Idaho on granitic soils (Steele et al. 1981). This habitat type seems to be different in the northern Rocky Mountains.

Management Implications

Understory vegetation in this habitat type recovers slowly from major disturbance, except where *Populus tremuloides* is present. Conifer reproduction in this dry, moderately cool habitat type is more difficult to obtain, and competition between tree seedlings and understory vegetation is more severe than in the *Abies lasiocarpa/Vaccinium scoparium* habitat type. In fact, conifer tree seedlings often are slow to establish after clearcutting, especially if the site becomes fully occupied by *Populus tremuloides*, *Carex geyeri*, and associated undergrowth. *Pinus contorta* is the conifer species most likely to compete successfully with *Carex geyeri* following major disturbance. However, *Populus tremuloides* has a high potential for occupying the site following fire or other disturbance.

Timber productivity is average to below average. Cutting methods applicable are similar to those suggested for the *Abies lasiocarpa/Vaccinium scoparium* habitat type; however, seral stands of *Pinus contorta* are more likely to be susceptible to mountain pine beetle in the *Abies lasiocarpa/Carex geyeri* habitat type. Where there is an appreciable amount of either *Pinus contorta* or *Populus tremuloides* in the stands, clearcutting or simulated shelterwood is likely to increase their representation in the new stand. Growing stock levels of 120 to 140 are most appropriate for stands managed for timber (Alexander and Edminster 1980).

This habitat type provides summer forage for livestock and big game; but forage production is not as much as in seral stands dominated by *P. tremuloides*. Heavy grazing may reduce the *Carex geyeri* cover and expose soils difficult to revegetate. Natural runoff [12 to 15 inches (30 to 38 cm)] is usually less than in the *Abies lasiocarpa/Vaccinium scoparium* habitat type, but can be increased significantly using the same cutting methods suggested for *A. lasiocarpa/V. scoparium* habitat type.

Figure 15.—*Abies lasiocarpa/Carex geyeri* habitat type. The large amount of debris on the ground is typical of old-growth forests in the *Abies* series.

Figure 16.—*Abies lasiocarpa*/Moss spp. habitat type. Undergrowth is virtually nonexistent in this habitat type.

Abies lasiocarpa/Moss

Description

The *Abies lasiocarpa*/Moss habitat type generally occurs on ridges and moderately steep, upper slopes, often on soils derived from granites. The habitat type was observed throughout the Medicine Bow National Forest but was sampled in only the Snowy Range and on Pole Mountain, at elevations ranging from 8,600 feet (2,650 m) to 10,000 feet (3,050 m). This cold and dry habitat type, represented by three stands, is recognized by the overstory dominance of *Abies lasiocarpa* and *Picea engelmannii*. *Pinus contorta* is the principal seral species, but it is less evident than in other *Abies*-dominated habitat types. The diagnostic feature of this habitat type is sparse undergrowth of shrubs, graminoids, and forbs; moss spp. cover is evident because of the scarcity of other undergrowth. In some stands, *lichen* spp. cover may be higher than coverage by moss spp. (fig. 16).

This habitat type has been described in northern New Mexico by DeVelice et al. (1986) and on the Gunnison National Forest in south-central Colorado by Komarkova.[3] The *Abies lasiocarpa*/Moss habitat type has not been reported elsewhere by investigators using standard habitat type classification methodology (Alexander 1985).

Management Implications

Timber productivity in this habitat type is very low. Site indexes are low, growth is slow, and the potential for improvement is nil. Regeneration success, however, is likely to be good after either clearcutting in small openings or after partial cutting, because there is little undergrowth to compete with tree seedlings. Until more information is available, cutting methods suggested for perpetuating the *Abies lasiocarpa/Vaccinium scoparium* habitat type probably are applicable to this habitat type; however, regeneration may be more difficult following clearcutting. Livestock forage production is low, and there is little potential for improvement. Big game sum-

mer use is moderate, largely as cover for deer and elk that feed in adjacent habitat types. Natural runoff is probably equal to the *Abies lasiocarpa/Vaccinium scoparium* habitat type. Whether streamflow in the *Abies lasiocarpa*/Moss habitat can be increased by the cutting methods suggested for the *A. lasiocarpa/V. scoparium* habitat type is unknown.

Abies lasiocarpa/Vaccinium scoparium

Description

The *Abies lasiocarpa/Vaccinium scoparium* is a major habitat type throughout the Medicine Bow National Forest. This habitat type occurs throughout the Medicine Bow National Forest on subalpine sites that are cold and moderately moist with shallow, well-drained soils, from timberline to the drier *Pinus contorta*-dominated habitat types at lower elevations. This habitat type is represented by 42 stands, at elevations ranging from 8,600 to 10,600 feet (2,650 to 3,320 m), that were climax or near climax. The habitat type is recognized by the almost constant presence and reproductive success of *Abies lasiocarpa* and by the abundance and dominance of *Vaccinium scoparium* in the understory (Fig. 17). *Picea engelmannii* is present as a self-reproducing co-climax species.

The overstory of most of the stands is dominated by *Picea engelmannii*, with *Abies lasiocarpa* as a codominant. *Pinus contorta* is an important seral species and still dominates some of the stands in late stages of succession. However, the self-reproducing species in these stands are *Abies lasiocarpa* and *Picea engelmannii*. *Populus tremuloides* is only an occasional minor seral species. Ground cover varies from sparse to luxuriant, and *Vaccinium scoparium* is the only important shrub. Other important undergrowth species are *Arnica cordifolia*, *Carex* spp., *Erigeron peregrinus*, *Erythronium grandiflorum*, *Hieracium gracile*, and *Poa* spp.

The *Abies lasiocarpa/Vaccinium scoparium* habitat type, or others very similar to it, occur throughout the Rocky Mountains (Daubenmire and Daubenmire 1968; Hess and Alexander 1986; Hoffman and Alexander 1976, 1980, 1983; Mauk and Henderson 1984; Moir and Ludwig 1979; Pfister et al. 1977; Steele et al. 1981, 1983; Youngblood and Mauk 1985). However, there is considerable variability in the coverage of *Vaccinium scoparium* within this habitat type. Additionally, more broad-leaved herbaceous dicots occur in this habitat type on the western slope than on the eastern slope of the Rockies.

Figure 17.—*Abies lasiocarpa/Vaccinium scoparium* habitat type. *Picea engelmannii* is usually a codominant in this habitat type. Dead trees are remnants of late seral *Pinus contorta* overstory.

Management Implications

Timber productivity varies considerably (Alexander 1967). Understory vegetation changes slowly after major disturbance, and competition is not severe between tree seedlings and understory vegetation, except where coverage of herbaceous dicots and graminoids is high. Reproduction may be difficult to obtain on south slopes and other dry situations. There may be a manageable stand of advanced reproduction in much of this habitat type. While most silvicultural systems can be used (Alexander 1986a), complete removal of the mature overstory by clearcutting in mixed stands, where *Pinus contorta* makes up part of the overstory, may result in an even-aged replacement stand of seral *P. contorta*. This also can happen with the final harvest cut under shelterwood methods, unless extreme care is taken in logging to protect advanced regeneration of *Abies lasiocarpa* and *Picea engelmannii*. In these mixed stands, using a standard or modified shelterwood system, the proportion of *Pinus contorta* retained in the first cut can be used to manipulate the amount of *Abies lasiocarpa* and *Picea engelmannii* in the stand. Growing stock levels of 120 to 160 are appropriate for even-aged stands managed for timber production (Alexander and Edminster 1980).

If stands are clearcut, small 3- to 5-acre (1- to 2-ha) or 400-foot (122-m) wide openings are recommended. However, clearcutting is likely to eliminate the chance for regeneration of *P. engelmannii* on southerly exposures for extremely long periods of time. Where protection from direct solar radiation and excessive soil moisture losses is necessary for survival of *P. engelmannii* seedlings, standard or modified shelterwood are appropriate even-aged cutting methods. *Pinus contorta* may have to be planted on south aspects to maintain forest cover if the manager chooses to clearcut these sites. Clearcutting in large openings on other than south aspects also may require planting areas beyond the effective seeding distance of Engelmann spruce (Alexander and Edminster 1983).

Uneven-aged management with group selection and/or individual-tree selection cutting can be used in irregular-structured stands, or where the combination of openings and high forest is required to enhance recreational opportunities and amenity values. Group selection is likely to perpetuate the existing species mix, but may increase the proportion of *Pinus contorta*. Individual-tree selection will favor *Abies lasiocarpa* over *Picea engelmannii*, and in mixed stands, the proportion of both *A. lasiocarpa* and *P. engelmannii* will be increased, especially if the initial cutting removes a large proportion of *Pinus contorta*.

The *Abies lasiocarpa/Vaccinium scoparium* habitat type is not heavily used by livestock, but is good big game summer range (Walmo et al. 1972), and provides habitat for a large number of birds and nongame mammals (Scott et al. 1982). It occupies areas with the greatest potential for water yield [up to 15 inches (38 m) of natural runoff annually] on the Medicine Bow National Forest. Small patch [3- to 5-acre (1- to 2-ha)] or strip [400-foot (122-m)] clearcuts result in greater forage production for big game and larger increases in water available for streamflow than either standard shelterwood or individual-tree selection cutting (Alexander 1977, Leaf 1975, Leaf and Alexander 1975, Regelin and Wallmo 1978, Troendle 1983, Troendle and King 1985, Wallmo et al. 1972). If larger openings are cut, slash should be left in place to create surface roughness needed to retain snowpack.

Streamflow can be increased with partial cutting on north slopes, but the increase will be greater with clearcutting (Troendle and Meiman 1984). Increases in water yield can be nearly as favorable with group shelterwood and group selection cutting, with the openings near the maximum size [2 acres (0.8 ha)] as with clearcutting. Because of the increase in tree reproduction, forage production begins to decline in about 15 to 20 years, and water production in 20 to 30 years. Therefore, new openings must be cut periodically to maintain increases in forage and water.

OTHER PLANT COMMUNITIES

Several other tree-dominated plant communities present in the Medicine Bow National Forest were not included in this study. These components within a complex forest mosaic represent topographic, edaphic, or other special environmental conditions not characteristic in the major habitat types. The following are additional plant communities observed during this study.

JUNIPERUS SCOPULORUM SERIES

Small patches of this hardy, small tree are found in the southern portion of Laramie Peaks and on the west side of the Snowy Range on dry, rocky ridges at lower elevations. *J. scopulorum* also occurs as an accidental in the *Pinus ponderosa/Carex geyeri* habitat type.

PSEUDOTSUGA MENZIESII SERIES

Pseudotsuga menziesii is poorly represented in the forested areas studied. No communities dominated by this tree were observed in either the Laramie Peaks or Sierra Madre areas. However, it does appear at low elevations on the western margins of the Snowy Range area (Hana 1934), and on shaded slopes on the north side of Telephone Canyon between Laramie and Cheyenne. At the latter location, it was heavily logged in the past, probably during the construction of the Union Pacific Railroad. It is quite possible that these trees are remnants from previous extensive forests of this species. Douglas' (1913) vegetation map of the Medicine Bow National Forest shows *Pseudotsuga* stands on the west side of the Snowy Range.

QUERCUS GAMBELII SERIES

Quercus gambelii, a small deciduous tree or shrub, is abundant in the dry foothills and canyon walls on the southwestern edge of the Sierra Madre area. Generally, it is confined to the lower fringes of the montane zone below the *Abies-Picea* and *Pinus contorta* zones. This warm, dry site community was not observed in any other area of the Medicine Bow National Forest.

ALNUS TENUIFOLIA SERIES

This community was observed along the roadside and streambanks on the western slope of the Sierra Madre and in the Laramie Peaks areas. Usually, it is confined to pond borders and moist sites adjacent to mountain streams, but it may form more extensive stands in other moist areas. *Alnus tenuifolia* is associated with the distribution of the *Abies lasiocarpa/Vaccinium scoparium* habitat type on the Medicine Bow National Forest.

KEY TO FOREST HABITAT TYPES

The following key to the major forest associations of southeastern Wyoming has been prepared to identify habitat types and phases present in relatively undisturbed stands.

1. Coniferous trees dominant and reproducing; deciduous trees may be present but are rare or not reproducing sufficiently to become dominant.
    2. *Pinus ponderosa* dominant and reproducing; other conifers absent or, if present, not dominant or reproducing.
        3. Undergrowth dominated by shrubs; graminoids and forbs present but not dominant; *Arctostaphylos uva-ursi* is dominant . . . . . *PINUS PONDEROSA/ ARCTOSTAPHYLOS UVA-URSI*
        3. Undergrowth dominated by graminoids; shrubs not common or not dominant.
            4. *Carex rossii* dominates the undergrowth; *Carex geyeri* absent or sparse; *Hesperochloa kingii* and *Koeleria cristata* present but not dominant . . *PINUS PONDEROSA/CAREX ROSSII*
            4. *Carex rossii* absent or sparse; *Carex geyeri* dominates the undergrowth; *Hesperochloa kingii* usually present but not dominant . . . . . *PINUS PONDEROSA/CAREX GEYERI*
    2. *Pinus ponderosa* absent, rare, or clearly seral; other conifers present and reproducing successfully.

5. *Pinus flexilis* climax and reproducing successfully; other conifers may be present but are not dominant or reproducing successfully.
    6. *Juniperus communis* dominates the undergrowth; herbaceous undergrowth present but very sparse ..... *PINUS FLEXILIS/JUNIPERUS COMMUNIS*
    6. *Juniperus communis* and other shrubs absent or poorly represented; *Hesperochloa kingii* dominates the undergrowth; *Carex geyeri* absent or sparse; shrubs poorly represented ..... *PINUS FLEXILIS/HESPEROCHLOA KINGII*
5. *Pinus flexilis* may be present but not reproducing vigorously, not climax; other conifers present and reproducing vigorously.
    7. *Pinus contorta* dominant, reproducing, and climax; other conifers may be present but are not reproducing vigorously.
        8. Shrubs dominate the undergrowth; herbaceous vegetation sparse or not dominant.
            9. Undergrowth dominated by *Vaccinium scoparium*; other shrubs may be present but not dominant ..... *PINUS CONTORTA/VACCINIUM SCOPARIUM*
            9. *Vaccinium scoparium*, if present, is sparse and not dominant.
        10. *Shepherdia canadensis* dominates the undergrowth; other shrubs may be present but not dominant ..... *PINUS CONTORTA/SHEPHERDIA CANADENSIS*
        10. *Shepherdia canadensis* may be present but not abundant or dominant; *Juniperus communis* dominates the undergrowth; other shrubs may be present but not abundant ..... *PINUS CONTORTA/JUNIPERUS COMMUNIS*
        8. Shrubs absent or poorly represented in the undergrowth; graminoids dominate the undergrowth.
            11. *Carex geyeri* dominates the undergrowth; *Calamagrostis rubescens* may be codominant; other graminoids absent or sparse ..... *PINUS CONTORTA/CAREX GEYERI*
            11. *Carex geyeri* absent or sparse in the undergrowth; *Carex rossii* dominates the depauperate undergrowth; other graminoids are sparse or absent ... *PINUS CONTORTA/CAREX ROSSII*
7. *Pinus contorta* absent or not reproducing well; *Abies lasiocarpa* reproducing and climax; *Picea engelmannii* may dominate the overstory and reproduce successfully to maintain its population; *Populus tremuloides* may be present but not reproducing successfully.
    12. *Vaccinium scoparium* dominates the undergrowth; other shrubs and graminoids are sparse ..... *ABIES LASIOCARPA/VACCINIUM SCOPARIUM*
    12. *Vaccinium scoparium* sparse or absent.
        13. *Carex geyeri* dominates the undergrowth; mosses and/or lichens absent or sparse ... *ABIES LASIOCARPA/CAREX GEYERI*
        13. *Carex geyeri* absent or sparse; moss spp. and/or lichen spp. dominate the depauperate undergrowth .. *ABIES LASIOCARPA/MOSS*
1. Coniferous trees absent or minor, not climax; *Populus tremuloides* present and reproducing successfully.
    14. Graminoids dominate the undergrowth; shrubs are absent or sparse; forbs present but not dominant.
        15. *Carex geyeri* dominates the undergrowth; *Calamagrostis rubescens* is absent or rare ..... *POPULUS TREMULOIDES/CAREX GEYERI*
        15. *Carex geyeri* may be conspicuous but does not dominate the undergrowth; *Calamagrostis rubescens* dominates the undergrowth .... *POPULUS TREMULOIDES/CALAMAGROSTIS RUBESCENS*
    14. Undergrowth dominated by tall forbs; shrubs rare, graminoids present but not dominant .. .. *POPULUS TREMULOIDES/THALICTRUM FENDLERI*

The distribution and successional status of tree species in relation to habitat type are shown in table 2.

DISCUSSION

VALIDITY OF HABITAT TYPE CLASSIFICATION

The practical value of the habitat type classifications has only begun to be realized in areas of vegetation mapping, relation to tree growth, susceptibility to diseases, production of browse species for game animals, understanding natural succession, and in providing a framework within which to relate additional basic or applied biological studies (Daubenmire 1961, 1973, 1976).

The classification system, while using vegetation as the indicator of site potentials, combines available related information on soil and climate. While initially using vegetation as the criterion for delineating habitat types, this approach also takes a holistic view of units of land area. Assuming that disturbances, such as fire, grazing, etc., have not occurred, the older the stands observed, the more closely they approximate the potential (climax or near climax) of the landscape units studied (Daubenmire 1976).

This classification system utilizes both overstory and undergrowth vegetation in recognizing habitat types. In this study, the two major vegetation zones are dominated by *Pinus contorta*, and *Abies lasiocarpa* and *Picea engelmannii*. It is apparent that the *Pinus contorta* zone

Table 2.—Distribution and successional status of tree species in relation to habitat type on the Medicine Bow National Forest.

Habitat type	Species						
	Pinus flexilis	*Pinus ponderosa*	*Pseudotsuga menziesii*	*Populus tremuloides*	*Pinus contorta*	*Picea engelmannii*	*Abies lasiocarpa*
Pinus ponderosa/Arctostaphylos uva-ursi	o	C		S			
Pinus ponderosa/Carex rossii		C					
Pinus ponderosa/Carex geyeri	a	C	*o*	S	a	a	a
Populus tremuloides/Carex geyeri	*o*			C	o		*o*
Populus tremuloides/Calamagrostis rubescens				C	o	a	a
Populus tremuloides/Thalictrum fendleri				C	a	a	*o*
Pinus flexilis/Hesperochloa kingii	C						
Pinus flexilis/Juniperus communis	C			a	o		o
Pinus contorta/Juniperus communis	o			*o*	C	a	a
Pinus contorta/Carex rossii	o	a	a		C	a	a
Pinus contorta/Shepherdia canadensis	*o*	a		a	C	a	a
Pinus contorta/Carex geyeri		o		s	C	a	*o*
Pinus contorta/Vaccinium scoparium					C	a	o
Abies lasiocarpa/Vaccinium scoparium					S	C	C
Abies lasiocarpa/Carex geyeri				S	S	C	C
Abies lasiocarpa/Moss	*o*			o	s	C	C

C = major climax, S = major seral, s = minor seral, o = occasional, a = accidental

on the Medicine Bow National Forest and elsewhere in Wyoming is warmer and drier than the *Abies* zone. Edaphic factors are also more alike within than between zones. The classification of habitat types recognizes climax tree species in an area; these are given primary consideration, and important seral species are noted. Undergrowth vegetation is then used to indicate habitat types within the zone where a given tree species is climax.

Within the *Pinus contorta* zone of the Medicine Bow National Forest, five habitat types were recognized based on relatively few species. The *Pinus contorta/Vaccinium scoparium* habitat type is considered a climatic climax. The *Pinus contorta/Vaccinium scoparium* habitat type occupies soil apparently developed in place through normal processes throughout the zone. The *P. contorta/C. geyeri* habitat type is considered to be a topo-edaphic climax that generally occupies warmer and drier, south-facing sites at upper edges of the zone. Throughout the *Pinus contorta* zone, there are restricted areas where combinations of edaphic and topographic characteristics allow *Shepherdia canadensis*-, *Carex rossii*-, and *Juniperus communis*-dominated undergrowth to establish under *Pinus contorta*. Although the *Pinus contorta/Vaccinium scoparium* habitat type is the dominant climatic climax throughout much of the *Pinus contorta* zone, undergrowth vegetation is expressed rather independently of the *Pinus contorta* overstory.

In the *Abies lasiocarpa* zone, two of the three habitat types, *Abies lasiocarpa/Vaccinium scoparium* and *Abies lasiocarpa/Carex geyeri*, are distinguished by differences in relatively few undergrowth species. The third habitat type, *Abies lasiocarpa*/Moss, is distinguished by the sparse shrub, graminoid, and forb undergrowth. The *A. lasiocarpa/V. scoparium* and *A. lasiocarpa/C. geyeri* habitat types also show some topographic and elevational differences. Additionally, while *Pinus contorta* may be an important seral species in both of these habitat types, *Populus tremuloides* is an important seral species only in the *Abies lasiocarpa/Carex geyeri* habitat type. In the *Abies lasiocarpa*/Moss habitat type, neither *P. contorta* nor *P. tremuloides* appear to be important seral species.

Populus tremuloides also is widespread on the Medicine Bow National Forest and occupies about the same elevational range as *Pinus contorta*. Within *Populus*-dominated forests, three habitat types were recognized. The *Populus tremuloides/Carex geyeri* and *Populus tremuloides/Calamagrostis rubescens* habitat types are topo-edaphic climaxes. The *Populus tremuloides/Thalictrum fendleri* habitat type is a climatic climax. To better characterize this habitat type, additional sampling should be done in stands least affected by grazing and those with poor drainage. *Lathyrus leucanthus* tends to increase with grazing, while *Thalictrum fendleri* decreases. *Ligusticum filicinum* often dominates the undergrowth, especially where drainage is poor.

Extensive stands of *Pinus ponderosa* are confined to the Laramie Peaks unit, where stands tend to be open and timber production potential low. Three habitat types were recognized—*Pinus ponderosa/Arctostaphylos uva-ursi*, which is climatic climax, and *Pinus ponderosa/Carex geyeri* and *Pinus ponderosa/Carex rossii*, which are topo-edaphic climaxes. The *Pinus flexilis* series, represented by two habitat types, is most extensive on Pole Mountain where open stands occur in small, dry, rocky sites. The *Pinus flexilis/Hesperochloa kingii* and *Pinus flexilis/Juniperus communis* habitat types are topo-edaphic climaxes.

DISTRIBUTION AND DYNAMICS OF FOREST TREE SPECIES

Pinus contorta is the most widely distributed tree on the Medicine Bow National Forest, reaching maximum development at elevations between 8,000 feet (2,440 m) and 10,000 feet (3,050 m). At its upper limits, *P. contorta* extends into the *Abies lasiocarpa* zone. The role of *P. contorta* as a seral and/or climax species has been discussed at length by Clements (1910), Stahelin (1943), and many others. Most investigators agree that *Pinus contorta* is an aggressive pioneer, and its occurrence is largely due to fire and logging.

There is less agreement on the stability of *Pinus contorta* once it is established. Data and observations on the Medicine Bow National Forest and elsewhere in Wyoming and Colorado suggest that both climax and seral stands of *P. contorta* occur (Hess and Alexander 1986; Hoffman and Alexander 1976, 1980, 1983). Seral *Pinus contorta* stands are quite obvious where *Abies lasiocarpa* and *Picea engelmannii* are the climax species. In *Abies*-dominated habitat types, either *Pinus contorta* or *Populus tremuloides* may become established first after disturbance, or they may establish simultaneously. The availability of *Pinus* seed or *Populus* root suckers determines which species initially becomes established.

Climax stands of *Pinus contorta* show no clear evidence of replacement. *Picea engelmannii* is rare in these stands; but an occasional *Abies lasiocarpa* may occur. The presence of few *Abies* seedlings, however, is not sufficient evidence of a successional trend. In addition, *Pinus contorta* has the diameter distribution of a stable population structure, characteristic of climax forests. However, the understory vegetation of *Pinus contorta*-dominated habitat types is not distinct from *Abies*- and *Picea*-dominated habitat types. Most *Pinus contorta*-dominated habitat types appear to result from topographic and/or edaphic factors.

Abies lasiocarpa and *Picea engelmannii* dominate the vegetation in the subalpine zone, which occurs from about 9,000 feet (2,740 m) to timberline. Neither species is important in other elevational zones. From the population structures of early seral communities, it appears that after severe fire in the subalpine zone, early successional communities are often a mixture of heliophytic shrubs, herbs, and cryptogams. In some localities, this stage of succession is prolonged, especially where the combination of a lack of seed source and/or root suckers and severe climatic conditions slow succession after large fires. Where abundant seeds and/or root suckers are available, fire can be followed promptly by *Pinus contorta* and/or *Populus tremuloides* regeneration. In situations where fire or other disturbance is not severe, climatic conditions are favorable and seral species absent or sparse, climax species can be replaced by climax species.

For example, in the *Abies lasiocarpa/Vaccinium scoparium* and *Abies lasiocarpa*/Moss habitat types, *Abies lasiocarpa*- and *Picea engelmannii*-dominated forests may develop after fire or other disturbance without seral stages of either *Pinus contorta* or *Populus tremuloides*. This successional trend has not been observed in the *Abies lasiocarpa/Carex geyeri* habitat type, however.

There also can be some shifting of dominance within the seral communities. On the Medicine Bow National Forest, *Pinus contorta*-dominated forests may become *Pinus contorta/Populus tremuloides*-dominated forests if *Populus* is present and *Pinus* does not fully occupy the site, or *Pinus* stands begin to break-up. The reverse of this also happens with *Pinus-Populus*-dominated forests becoming *Pinus*-dominated forests. *Populus tremuloides*-dominated forests may add *Pinus contorta* before succession to *Abies*-dominated forests is completed; but *Pinus-Populus*-dominated forests usually do not lose the *Pinus* component before succeeding to *Abies*-dominated forests.

Populus tremuloides also is a widely distributed tree on the Medicine Bow National Forest, reaching maximum abundance at the same elevations as *Pinus contorta* [8,500 feet (2,590 m) to 10,000 feet (3,050 m)]. At its upper elevational limits, *Populus tremuloides* also extends into the *Abies lasiocarpa* zone. The role of *Populus tremuloides* as seral and/or climax species also has been discussed at length by Mueggler (1985a), Mueggler and Campbell (1982), Youngblood and Mueggler (1981), and others. Most investigators have agreed that *Populus tremuloides* is an aggressive species on areas that have been burned, logged, or otherwise disturbed, reproducing primarily by root suckers. There is less agreement on the stability of *Populus tremuloides* once it is established. Data and observations from the present study suggest that both seral and climax stands of *Populus tremuloides* occur in the Medicine Bow National Forest, as were observed in earlier studies on the Arapaho, Roosevelt, Routt, and White River National Forests (Hess and Alexander 1986; Hoffman and Alexander 1980, 1983).

Climax stands of *Populus tremuloides* show no clear evidence of successful conifer invasion. *Picea engelmannii* and *Pinus contorta* are rare in these stands, although an occasional *Abies lasiocarpa* may occur. The presence of a limited number of coniferous seedlings in the undergrowth is not sufficient evidence of a successional trend, however. In addition, *Populus* usually has the diameter distribution of a stable population structure. Although the understory vegetation of the *Populus*-dominated habitat types is distinct, a number of species are shared between *Populus tremuloides*-dominated habitat types and other habitat types in the Forest.

Some soils differences exist between *Populus*-dominated, and *Pinus contorta*- and *Abies*-dominated habitat types. The oldest stands of climax *Populus*-dominated habitat types on the Medicine Bow National Forest were about 180 years old, and it is unknown if these trees are first generation after fire. If succession toward *Pinus*, and *Abies* and *Picea* forests is not evident in these stands, they should be viewed and managed as climax forests.

Pinus flexilis habitat types also occur at the same elevational range as *Pinus contorta* and *Populus tremuloides*, but on dry and warm sites where soils are shallow and rocky.

The absence of a well-defined *Pseudotsuga* zone over much of the Medicine Bow National Forest probably results from drought at low elevations and low temperatures at higher elevations (Moir 1969). Moreover, *Pseudotsuga menziesii* shows little tendency to establish in areas now occupied by *Populus tremuloides*, *Pinus contorta*, or *Pinus ponderosa*. Nor are there relics of *Pseudotsuga menziesii* in these stands to suggest it was formerly present.

The *Pinus ponderosa* zone is the lowest and driest forested zone on the Medicine Bow National Forest. *Pinus ponderosa* grows from 6,000 feet (1,830 m) to 8,500 feet (2,590 m), but reaches maximum development between 6,500 feet (1,980 m) to 8,000 feet (2,440 m). *Pinus ponderosa* formerly was more widespread on the Medicine Bow National Forest; but fires and timber harvesting have left only Laramie Peaks with extensive stands.

FURTHER STUDIES IN RELATION TO THE HABITAT TYPES

The present study was done to provide a basic classification of the forest habitat types in the Medicine Bow National Forest. There are numerous areas of research which logically follow this study.

The production of undergrowth vegetation in relation to habitat types needs to be examined. Ellison and Houston (1958), and Mueggler (1985b) suggested that production of vegetation under *Populus tremuloides* could be used as an indicator of forage production and, therefore, range condition. In the Medicine Bow National Forest, both cattle and sheep utilize, sometimes quite heavily, vegetation under *Populus*. It would be valuable to know the relationship between habitat types and potential undergrowth productivity.

The growth rates of important timber trees may correlate with habitat types similar to the relationship of growth rates of *Pinus ponderosa* and the habitat types in the northern Rocky Mountains described by Daubenmire (1961).

Numerous fungi attack *Populus tremuloides* (Hinds 1985), and some *Populus* habitat types may be more susceptible to various species of fungi than others are. In northern Idaho and eastern Washington, *Arceuthobium* infects *Pinus ponderosa* in the *Pinus ponderosa*/*Agropyron spicatum* and *Pinus ponderosa*/*Purshia tridentata* habitat types, but not in other habitat types dominated by *Pinus ponderosa* (Daubenmire 1961). Susceptibility of *Picea engelmannii* to insect infestation may be correlated with habitat types in Colorado (Shepherd 1950).

The relationship of forest habitat types and their successional stages to wildlife management and increased water yields following timber harvest also needs further research.

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Table A-1.—Tree population structure for each habitat or community type. Number of trees listed are based on sample plot data of 375 m^2 per stand.

Habitat or community type and species	No. stands sampled	Diameter (b.h.) classes in dm								
		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8+
Pinus ponderosa/Carex geyeri	6									
Pinus ponderosa		19	10	8	4	1	1	(1)	(1)	(1)
Populus tremuloides		20	0	0	0	0	0	0	0	0
Pinus contorta		(1)	0	0	0	0	0	0	0	0
Pseudotsuga menziesii		4	(1)	0	0	0	0	0	0	0
Pinus flexilis		1	0	0	0	0	0	0	0	0
Abies lasiocarpa		1	0	0	0	0	0	0	0	0
Picea engelmannii		(1)	0	0	0	0	0	0	0	0
Pinus ponderosa/Arctostaphylos uva-ursi	5									
Pinus ponderosa		29	10	4	2	1	1	1	(1)	1
Populus tremuloides		40	(1)	0	0	0	0	0	0	0
Pinus flexilis		6	0	0	0	(1)	0	0	0	0
Pinus ponderosa/Carex rossii	2									
Pinus ponderosa		42	10	2	2	1	1	0	0	0
Populus tremuloides/Carex geyeri	11									
Populus tremuloides		292	41	13	3	(1)	0	0	0	0
Abies lasiocarpa		5	(1)	0	0	0	0	0	0	0
Pinus contorta		3	0	(1)	0	0	0	0	0	0
Pinus flexilis		2	(1)	0	0	0	0	0	0	0
Populus tremuloides/Calamagrostis rubescens	5									
Populus tremuloides		80	27	13	3	(1)	0	0	0	0
Abies lasiocarpa		1	0	0	0	0	0	0	0	0
Picea engelmannii		(1)	0	0	0	0	0	0	0	0
Pinus contorta		53	(1)	(1)	(1)	0	0	0	0	0
Populus tremuloides/Thalictrum fendleri	3									
Populus tremuloides		74	21	12	2	2	(1)	(1)	2	0
Abies lasiocarpa		18	(1)	0	0	0	0	0	0	0
Picea engelmannii		0	0	(1)	0	0	0	0	0	0
Pinus contorta		1	(1)	(1)	0	0	0	0	0	0
Pinus flexilis/Hesperochloa kingii	8									
Pinus flexilis		33	6	5	2	1	(1)	0	(1)	0
Pinus flexilis/Juniperus communis	2									
Pinus flexilis		7	6	2	2	2	0	(1)	0	0
Pinus contorta		0	2	(1)	0	0	0	0	0	0
Abies lasiocarpa		3	0	0	0	0	0	0	0	0
Populus tremuloides		9	0	0	0	0	0	0	0	0
Pinus contorta/Vaccinium scoparium	10									
Pinus contorta		146	9	9	5	1	(1)	(1)	0	(1)
Abies lasiocarpa		16	(1)	(1)	0	0	0	0	0	0
Picea engelmannii		1	0	(1)	0	0	0	0	0	0
Pinus contorta/Carex geyeri	8									
Pinus contorta		58	16	13	3	0	0	0	0	0
Abies lasiocarpa		4	0	0	0	0	0	0	0	0
Populus tremuloides		46	0	0	0	0	0	0	0	0
Pseudotsuga menziesii		(1)	0	0	0	0	0	0	0	0
Pinus ponderosa		3	(1)	(1)	0	0	0	0	0	0
Pinus flexilis		1	0	0	0	0	0	0	0	0
Pinus contorta/Juniperus communis	4									
Pinus contorta		52	15	12	3	2	(1)	0	(1)	0
Abies lasiocarpa		2	0	0	0	0	0	0	0	0
Picea engelmannii		4	0	0	0	0	0	0	0	0
Populus tremuloides		24	0	0	0	0	0	0	0	0
Pinus flexilis		24	0	0	0	0	0	0	0	0
Pinus contorta/Shepherdia canadensis	2									
Pinus contorta		15	16	9	2	0	0	0	0	0
Abies lasiocarpa		2	0	0	0	0	0	0	0	0
Populus tremuloides		(1)	0	0	0	0	0	0	0	0
Pinus flexilis		10	(1)	0	0	0	0	0	0	0

Pinus contorta/Carex rossii	5								
Pinus contorta		112	9	11	5	2	1	1	(1)	0
Abies lasiocarpa		2	0	0	0	0	0	0	0	0
Picea engelmannii		1	0	0	0	0	0	0	0	0
Pinus flexilis		5	(1)	0	0	0	0	0	0	0
Pseudotsuga menziesii		(1)	(1)	0	0	0	0	0	0	0
Pinus ponderosa		0	(1)	0	(1)	0	0	0	0	0
Abies lasiocarpa/Vaccinium scoparium	42								
Abies lasiocarpa		146	6	3	1	(1)	(1)	0	0	0
Picea engelmannii		52	6	4	2	1	1	1	(1)	(1)
Pinus contorta		4	3	3	2	1	(1)	(1)	(1)	(1)
Abies lasiocarpa/Carex geyeri	4								
Abies lasiocarpa		544	1	1	(1)	0	0	0	0	0
Picea engelmannii		7	0	0	(1)	0	0	0	0	0
Pinus contorta		15	5	9	2	(1)	0	0	0	0
Populus tremuloides		24	20	8	1	0	0	0	0	0
Abies lasiocarpa/Moss	3								
Abies lasiocarpa		233	8	2	0	0	0	0	0	0
Picea engelmannii		58	8	3	5	3	1	(1)	0	0
Pinus contorta		1	2	1	0	0	0	0	0	0
Populus tremuloides		9	0	0	0	0	0	0	0	0
Pinus flexilis		7	0	(1)	0	0	0	0	0	0

(1) = *less than 1 tree per dm class.*

Table A-2.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Pinus ponderosa/Carex geyeri*, *Pinus ponderosa/Arctostaphylos uva-ursi*, and *Pinus ponderosa/Carex rossii* habitat types.

	Pinus/C. geyeri						*Pinus/Arctostaphylos*					*Pinus/ C. rossii*	
Plot	**288**	**229**	**243**	**207**	**203**	**305**	**237**	**239**	**228**	**244**	**249**	**238**	**240**
Shrubs													
Amelanchier alnifolia	+/4	—	—	1/2	—	+/2	/+	/+	+/2	—	—	—	—
Arctostaphylos uva-ursi	8/14	1/2	+/+	/+	—	—	49/100	34/98	28/72	9/42	2/20	/+	—
Artemisia tridentata	1/6	—	—	—	—	5/22	—	—	—	—	/+	—	/+
Berberis (Mahonia) repens	+/6	+/2	3/34	+/2	—	—	/+	1/32	5/46	3/34	—	—	—
Ceanothus fendleri	—	+/2	—	+/2	—	—	—	—	—	—	—	1/2	—
Juniperus communis	6/8	—	/+	/+	+/+	1/8	/+	—	/+	/+	+/2	—	+/+
Prunus virginiana	—	—	—	1/8	—	—	—	/+	—	+/2	—	—	+/+
Purshia tridentata	1/4	1/2	—	—	/+	2/8	/+	—	/+	—	1/6	+/4	3/12
Ribes cereum	—	—	—	—	—	+/2	—	+/+	—	—	+/2	—	—
Ribes inerme	—	—	3/22	—	—	—	—	—	—	—	—	—	1/4
Rosa acicularis	—	—	—	—	—	—	—	—	—	1/4	—	—	—
Rosa woodsii	+/6	—	+/4	—	—	—	+/10	1/20	1/14	1/20	—	—	—
Shepherdia canadensis	—	—	—	/+	—	—	—	/+	—	/+	—	—	—
Symphoricarpos albus	—	—	+/14	2/4	—	—	6/54	1/24	2/12	1/22	—	—	—
Symphoricarpos occidentalis	—	—	+/2	—	—	—	—	+/6	—	3/36	—	—	—
Graminoids													
Agropyron spicatum	2/18	—	—	—	—	2/26	—	—	—	—	—	+/4	+/2
Bromus ciliatus	1/2	—	—	—	—	—	—	—	—	—	—	—	—
Bromus marginatus	—	—	1/8	—	—	—	—	2/8	—	+/2	—	—	+/10
Bromus tectorum	—	5/22	—	—	—	—	+/12	—	—	—	—	—	+/4
Calamagrostis canadensis	—	—	+/16	—	—	—	—	—	—	—	—	—	—
Carex geyeri	22/68	11/46	26/92	27/82	3/28	30/62	2/20	—	1/10	+/2	—	—	+/6
Carex rossii	—	—	—	—	—	—	1/12	1/10	—	—	+/14	6/50	3/40
Festuca spp.	3/34	—	—	—	—	1/8	—	—	—	—	+/2	—	4/28
Hesperochloa kingii	3/14	10/56	—	1/10	2/10	5/32	/+	/+	4/44	—	2/24	1/10	4/28
Koeleria cristata	—	—	—	—	—	+/2	—	—	—	—	—	5/48	+/2
Melica subulata	—	—	—	—	—	—	—	1/26	—	+/6	—	—	—
Oryzopsis asperifolia	—	—	—	—	—	—	—	+/20	—	4/54	—	+/2	—
Poa interior	+/2	—	—	—	—	1/8	—	—	—	—	+/12	—	—
Poa nervosa	/+	—	—	—	—	+/4	+/4	—	—	+/2	—	+/8	2/40
Poa pratensis	—	—	1/18	—	—	—	—	—	—	—	+/4	—	—
Poa secunda	/+	—	—	—	—	—	—	—	—	—	—	5/38	+/10
Forbs													
Achillea lanulosa	1/38	2/32	2/42	+/4	+/4	+/8	5/64	3/64	2/32	1/38	+/12	2/26	1/22
Agoseris glauca	—	+/6	—	—	—	—	—	+/6	—	1/22	—	—	+/2
Allium textile	—	+/2	+/10	—	—	—	—	—	/+	—	—	+/6	1/18
Anaphalis margaritacea	—	—	—	—	—	—	—	—	—	5/40	—	—	—
Antennaria anaphaloides	—	—	4/26	—	—	—	—	—	—	—	/+	—	1/18
Antennaria rosea	4/46	3/26	+/8	1/18	+/2	+/+	2/22	+/+	+/4	—	+/12	+/12	1/22
Apocynum androsaemifolium	—	2/26	—	+/4	—	—	+/8	1/22	+/18	+/6	—	/+	—
Arenaria congesta	1/18	—	—	—	—	+/12	—	—	—	—	+/10	—	—
Arnica cordifolia	1/6	+/2	2/26	9/36	—	—	5/82	2/50	4/60	5/90	—	—	+/+
Artemisia ludoviciana	—	3/28	—	—	—	—	—	—	/+	—	+/8	/+	—
Aster glaucodes	—	—	—	—	—	—	+/8	—	1/10	—	—	—	1/18
Aster laevis	+/6	—	—	—	—	—	+/6	4/52	—	7/78	—	—	—
Athyrium filix-femina	—	+/2	—	—	—	—	—	+/+	/+	—	—	—	+/4
Balsomorhiza sagittata	/+	+/+	—	—	—	+/+	—	—	+/+	—	—	—	—
Besseya plantaginea	—	—	+/6	—	/+	—	—	—	—	—	—	—	1/20
Campanula rotundifolia	+/2	1/12	1/14	+/6	+/8	1/16	+/2	+/6	+/6	+/2	—	+/6	+/6
Castilleja septentrionalis	/+	—	+/2	—	—	—	—	+/+	—	+/4	—	—	—
Cerastium arvense	—	1/22	+/4	1/16	+/2	—	/+	/+	1/2	—	—	3/40	1/24
Cirsium canescens	/+	+/+	—	—	—	/+	/+	+/4	+/2	/+	—	—	—
Collinsia parviflora	—	—	+/8	—	—	—	—	—	—	—	—	—	+/10
Collomia linearis	—	1/22	—	—	—	—	—	—	—	—	—	—	—
Crepis acuminata	+/10	/+	+/2	+/8	+/2	/+	—	+/2	/+	—	/+	+/2	+/14
Dalea purpurea	—	—	—	—	—	—	—	—	—	3/20	—	—	—
Delphinium nelsonii	—	1/2	+/2	/+	—	—	—	—	+/+	—	—	+/+	+/2
Equisetum arvense	—	—	—	—	—	—	—	+/2	—	1/14	—	—	—
Erigeron flagellaris	+/8	—	—	—	—	/+	—	—	—	—	+/10	—	—
Erigeron glabellus	—	—	—	—	—	—	+/4	—	—	+/12	—	+/2	—
Erigeron peregrinus	—	+/4	—	—	—	—	—	—	+/2	—	—	—	—
Erigeron speciosus	+/2	—	—	+/2	+/2	—	—	—	—	—	—	—	—
Erysimun asperum	—	—	/+	—	—	—	—	—	—	—	+/+	—	+/+
Fragaria americana	—	—	—	—	—	—	—	+/8	—	+/8	—	—	—

Table A-2.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Pinus ponderosa/Carex geyeri*, *Pinus ponderosa/Arctostaphylos uva-ursi*, and *Pinus ponderosa/Carex rossii* habitat types.—Continued

	Pinus/C. geyeri						*Pinus/Arctostaphylos*					*Pinus/ C. rossii*	
Plot	**288**	**229**	**243**	**207**	**203**	**305**	**237**	**239**	**228**	**244**	**249**	**238**	**240**
Fragaria ovalis	—	/ +	—	—	—	—	+ /20	—	1/26	—	/ +	—	—
Frasera speciosa	—	—	1/6	+ /2	—	—	—	+ /4	—	+ /4	—	—	—
Galium boreale	/ +	—	4/70	—	—	—	—	1/34	—	6/74	—	—	—
Geranium fremontii	—	+ / +	1/14	/ +	1/14	—	—	—	—	—	+ /8	—	—
Geranium richardsonii	—	—	—	—	—	—	—	+ /8	—	/ +	—	/ +	—
Harbouria trachypleura	—	—	—	—	5/44	—	—	—	— —	+ /2	—	+ /8	
Helianthus pumilus	—	+ /2	—	—	—	—	—	—	—	—	—	—	/ +
Heterotheca villosa	—	—	—	—	—	—	—	—	—	—	—	+ /2	+ /2
Heuchera parviflora	—	—	—	—	/ +	—	—	—	—	—	—	—	+ /2
Hieracium albiflorum	—	+ /2	—	+ / +	—	—	+ / +	+ /4	2/38	—	+ /2	—	—
Lithospermum incisum	—	—	—	—	—	—	—	—	+ /2	—	—	—	1/2
Lupinus argenteus	3/38	+ / +	8/52	—	—	—	9/70	4/30	5/42	1/20	—	—	—
Mentha arvense	—	—	—	—	—	—	—	2/20	—	2/28	—	—	+ /8
Mertensia lanceolata	—	1/8	—	—	/ +	—	—	—	—	—	—	—	—
Osmorhiza depauperata	—	—	—	1/8	—	—	—	+ /14	—	+ /12	—	—	—
Oxytropis campestris	—	—	+ /2	—	—	/ +	—	—	—	—	—	—	1/20
Penstemon spp.	—	/ +	—	—	/ +	—	—	+ / +	+ / +	—	+ /6	+ /4	/ +
Plox multiflora	1/8	—	—	—	—	—	—	—	—	—	—	—	2/22
Potentilla fissa	/ +	4/26	—	+ /2	1/16	+ /6	1/26	+ / +	1/4	—	+ /6	+ /2	1/16
Pteridium aquilinum	—	—	—	—	—	—	—	4/30	—	38/76	—	—	—
Pulsatilla ludoviciana	—	—	1/30	—	—	—	—	—	—	—	+ /8	—	1/26
Ranunculus ranunculinus	—	+ /6	+ /10	—	—	—	—	—	—	—	—	—	1/12
Sanicula marilandica	—	—	—	—	—	—	—	+ /2	—	1/28	—	—	—
Scutellaria brittonii	—	+ / +	—	—	—	—	—	—	—	—	—	+ /8	+ /2
Sedum lanceolatum	+ /22	/ +	—	—	/ +	—	—	+ / +	+ / +	—	+ /4	+ /10	+ /4
Senecio fendleri	—	+ /6	—	—	—	—	—	—	/ +	—	+ / +	/ +	+ / +
Senecio integerrimus	—	—	+ / +	—	—	—	—	—	—	—	—	—	+ /8
Smilicina stellata	—	—	2/20	—	—	—	—	+ /4	—	/ +	—	—	—
Taraxacum officinale	—	—	1/18	—	—	—	—	—	—	—	—	—	—
Thalictrum fendleri	—	—	—	—	—	—	—	—	—	2/34	—	—	—
Vicia americana	—	/ +	—	—	—	1/10	1/18	1/24	—	+ /2	—	—	—
Viola adunca	—	+ / +	+ /6	—	—	/ +	+ /2	+ /2	+ /2	+ /2	—	+ /2	+ /2
Moss and Lichen	3/46	—	1/12	—	—	+ /4	+ /6	—	—	—	—	+ /22	5/36

\+ = *less than 0.5%.*

Table A-3.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Populus tremuloides/Carex geyeri* habitat type.

Plot	289	304	310	181	257	303	231	262	245	266	242
Shrubs											
Acer glabrum	2/16	—	—	—	—	—	—	—	+/8	—	—
Amelanchier alnifolia	+/2	/+	—	1/2	+/2	—	—	/+	—	1/8	
Arctostaphylos uva-ursi	—	+/+	—	—	—	14/38	—	—	1/6	—	+/4
Berberis (Mahonia) repens	18/62	/+	4/58	10/62	+/6	+/6	—	1/10	2/22	1/16	/+
Juniperus communis	1/6	6/16	19/48	11/20	5/16	1/4	5/14	1/4	6/14	+/+	+/6
Prunus virginiana	/+	—	—	—	—	—	—	—	—	/+	—
Rosa woodsii	3/30	+/2	3/20	10/62	5/66	2/24	—	1/8	1/42	—	+/6
Shepherdia canadensis	—	—	—	+/2	/+	—	—	/+	/+	—	—
Symphoricarpos albus	—	—	—	/+	—	—	1/6	1/8	1/24	+/2	1/10
Symphoricarpos occidentalis	—	—	—	—	/+	—	—	1/8	1/12	3/24	—
Graminoids											
Agropyron spicatum	—	—	—	—	—	—	—	/+	—	2/20	—
Agropyron subsecundum	+/6	—	—	—	—	—	—	—	—	—	—
Agropyron trachycaulum	—	+/2	—	—	—	—	—	—	—	+/12	—
Bromus ciliatus	—	1/18	1/22	—	—	+/12	—	—	+/2	—	—
Bromus marginatus	+/12	—	—	—	+/2	—	1/16	1/28	—	3/50	—
Calamagrostis canadensis	—	—	/+	—	—	—	—	—	—	—	+/12
Calamagrostis rubescens	—	2/18	—	—	—	—	—	—	—	—	—
Carex geyeri	60/98	52/94	44/98	41/96	37/96	37/94	37/84	33/98	18/90	13/44	1/12
Carex nebraskensis	—	—	—	—	—	—	—	—	—	—	1/12
Carex rossii	—	—	—	—	—	—	—	—	—	—	1/14
Elymus glaucus	/+	/+	+/2	16/70	45/98	+/2	+/8	—	—	—	—
Festuca idahoensis	—	—	—	—	—	—	+/8	—	+/+	—	—
Melica subulata	—	—	—	—	+/2	—	—	—	/+	1/28	7/64
Oryzopsis asperifolia	—	—	—	—	—	—	—	—	4/48	—	—
Phleum alpinum	—	+/2	+/+	—	—	—	—	—	—	+/+	+/10
Poa interior	/+	/+	—	—	—	—	—	+/4	—	—	
Poa nervosa	—	+/2	—	—	—	—	—	—	—	+/4	—
Poa pratensis	—	—	—	—	—	—	11/56	—	+/6	—	—
Poa reflexa	—	—	/+	—	+/2	—	—	—	—	1/30	—
Stipa columbiana	+/2	—	—	—	—	+/4	—	/+			
Trisetum spicatum	/+	+/2	+/10	—	+/2	+/6	—	/+	1/26	2/34	—
Forbs											
Achillea lanulosa	2/44	2/50	+/6	—	+/2	+/8	1/10	5/66	3/62	4/32	1/16
Agoseris glauca	+/8	+/6	+/2	—	—	—	+/+	+/12	+/4	—	—
Allium brevistylum	—	+/12	—	—	/+	—	—	—	—	—	5/26
Antennaria rosea	+/4	—	—	—	—	—	—	—	+/4	/+	—
Arabis spp.	—	—	—	—	—	—	—	—	—	—	+/6
Arnica cordifolia	2/20	+/8	1/20	26/96	3/52	3/36	—	—	3/68	+/2	+/+
Aster engelmannii	/+	—	—	+/+	+/4	—	—	+/8	—	1/8	—
Aster laevis	2/20	—	+/12	—	—	+/4	—	—	7/68	—	—
Astragalus spatulatus	—	—	—	20/68	—	—	1/4	—	—	—	—
Campanula rotundifolia	+/8	—	/+	+/2	—	/+	+/+	—	—	—	—
Castilleja septentrionalis	—	—	/+	—	2/36	2/12	+/2	/+	1/20	+/2	+/2
Cerastium arvense	—	—	—	—	—	—	2/28	—	—	—	+/+
Chorispora tenella	—	—	—	—	—	—	—	—	—	—	+/6
Cirsium canescens	/+	—	—	5/36	+/4	+/4	1/4	+/2	—	+/2	+/+
Collomia linearis	—	—	—	—	—	—	1/14	—	—	2/26	—
Crepis acuminata	—	—	—	—	—	—	35/96	—	—	—	—
Delea purpurea	—	—	—	—	—	—	—	—	1/16	—	—
Delphinium occidentalis	/+	/+	—	—	—	—	—	—	—	—	—
Dodecatheon pulchellum	—	—	—	—	—	—	—	—	—	—	5/40
Epilobium angustifolium	—	1/10	+/4	2/34	+/2	+/2	—	—	—	—	4/64
Equisetum arvense	—	—	+/4	—	—	—	—	—	—	—	1/10
Erigeron peregrinus	+/2	+/4	2/34	1/8	3/40	+/8	—	—	+/8	+/2	1/22
Erigeron subtrinervis	/+	—	—	—	—	/+	—	—	—	—	—
Erythronium grandiflorum	—	—	—	—	—	—	—	+/20	—	+/8	—
Fragaria americana	—	+/18	5/58	—	—	—	—	—	3/68	—	—
Fragaria ovalis	—	2/50	—	—	—	+/8	+/4	3/46	—	+/2	+/8
Frasera speciosa	—	2/18	5/18	/+	/+	—	+/8	/+	—	—	
Galium boreale	6/70	+/16	3/56	12/74	+/10	—	5/20	+/20	2/72	13/58	+/14
Geranium fremontii	+/2	2/54	+/6	—	/+	—	1/14	—	2/48	—	—
Geranium richardsonii	—	—	—	—	—	—	—	—	—	—	2/14
Hieracium lanatum	—	—	—	—	—	—	—	—	—	—	+/+
Hieracium albiflorum	—	+/6	—	—	—	—	—	+/4	—	—	—

Table A-3.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Populus tremuloides/Carex geyeri* habitat type.—Continued

Plot	289	304	310	181	257	303	231	262	245	266	242
Lathyrus leucanthus	—	—	—	—	—	—	37/94	—	—	—	—
Ligusticum filicinum	8/38	+/16	3/40	—	+/2	+/8	—	2/28	—	—	—
Lomatium dissectum	—	—	—	—	—	—	3/18	—	—	—	—
Lupinus argenteus	1/8	—	2/16	—	+/12	6/56	/+	1/20	+/18	+/8	—
Osmorhiza depauperata	14/86	/+	2/26	2/40	3/74	—	8/56	3/84	5/76	4/38	+/10
Oxytropis campestris	—	1/20	13/56	—	14/90	14/84	—	—	—	—	—
Penstemon whippleanus	—	—	—	—	—	—	—	—	—	4/30	—
Perideridia gairdneri	—	—	—	—	—	—	1/16	—	—	1/26	1/46
Potentilla diversifolia	+/+	+/16	/+	—	/+	—	2/18	+/6	+/6	+/2	+/8
Potentilla fissa	—	—	—	—	—	+/6	—	—	+/2	—	—
Ranunculus sceleratus	—	—	—	—	—	—	—	—	2/18	—	4/56
Senecio crassulus	—	—	—	—	—	—	—	—	—	13/48	—
Senecio serra	—	—	/+	—	—	—	1/6	1/2	—	—	—
Smilicina stellata	/+	+/16	+/12	—	—	—	—	—	1/16	—	1/14
Stellaria jamesiana	—	—	—	—	—	—	—	—	+/8	—	1/14
Taraxacum officinale	+/10	1/40	+/4	—	+/4	/+	—	+/6	+/6	1/16	+/18
Thalictrum fendleri	+/+	4/52	4/60	+/2	+/+	—	+/4	—	+/22	2/16	+/4
Valeriana occidentalis	—	—	—	—	—	—	—	—	/+	+/6	—
Vicia americana	—	—	—	—	—	—	10/66	+/2	+/2	—	—
Viola adunca	—	+/2	/+	—	—	—	—	—	+/4	—	+/6
Viola nuttallii	—	+/12	—	—	1/24	—	+/8	2/34	—	4/62	—
Zygadenus elegans	—	+/4	—	—	—	—	—	—	1/24	—	1/12
Moss and Lichen	—	—	—	—	—	1/4	—	+/2	+/4	—	1/28

+ = *less than 0.5%.*

Table A-4.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Populus tremuloides/Calamagrostis rubescens* habitat type, and *Populus tremuloides/Thalictrum fendleri* community type.

Plot	*Populus/Calamagrostis*					*Populus/Thalictrum*		
	271	291	273	272	274	258	80	308
Shrubs								
Amelanchier alnifolia	—	/+	—	—	—	—	/+	—
Juniperus communis	/+	1/6	—	—	/+	/+	—	9/20
Ribes inerme	—	—	—	—	—	—	—	+/2
Rosa woodsii	—	+/2	—	—	/+	—	4/22	5/58
Symphoricarpos albus	—	—	+/+	—	—	—	+/2	—
Graminoids								
Agropyron smithii	—	—	+/2	1/24	+/4	—	—	—
Agropyron subsecundum	—	+/6	—	—	—	—	—	—
Agropyron trachycaulum	+/12	—	—	—	—	—	—	+/6
Bromus marginatus	+/2	+/12	—	5/12	—	28/90	—	13/86
Calamagrostis rubescens	16/50	29/56	37/92	4/14	20/46	—	—	—
Carex geyeri	9/46	28/70	7/46	2/16	10/46	—	—	3/38
Carex rossii	—	—	—	—	—	—	3/16	—
Elymus glaucus	2/10	1/12	1/24	14/54	+/4	19/54	38/100	3/50
Festuca occidentalis	9/68	—	+/8	1/12	+/4	—	—	—
Melica subulata	—	—	—	2/46	—	1/12	—	—
Phleum alpinum	—	/+	—	+/2	—	/+	—	—
Poa pratensis	+/6	1/14	—	+/6	+/4	—	—	—
Poa reflexa	—	—	/+	1/10	+/4	1/12	—	—
Stipa columbiana	+/4	/+	+/2	—	+/2	—	—	—
Stipa lettermanii	—	—	—	+/2	—	—	—	—
Trisetum spicatum	+/4	1/18	+/2	+/4	+/12	—	—	—
Forbs								
Achillea lanulosa	1/6	+/10	2/22	3/20	+/12	+/8	3/26	1/24
Agoseris glauca	2/24	+/10	+/10	+/2	+/14	—	—	7/60
Allium spp.	—	—	—	—	+/+	—	—	+/2
Aquilegia caerulea	+/4	—	—	—	+/+	+/10	—	—
Arnica cordifolia	14/84	+/4	1/42	1/6	12/60	1/6	1/12	+/10
Aster engelmannii	—	+/6	—	+/2	—	—	—	—
Astragalus spatulatus	—	—	—	—	1/6	—	—	—
Campanula rotundifolia	—	/+	—	/+	+/+	—	—	—
Castilleja septentrionalis	—	+/+	—	—	—	—	—	—
Cerastium arvense	—	—	—	—	—	—	7/56	—
Cirsium canescens	—	1/4	—	—	—	—	—	4/24
Collomia linearis	—	—	+/+	3/48	—	—	—	—
Crepis acuminata	—	—	—	—	—	—	1/18	—
Delphinium nelsonii	—	—	—	+/2	—	—	—	—
Delphinium occidentalis	—	—	—	/+	—	12/26	—	1/6
Epilobium angustifolium	—	—	—	—	—	—	—	+/8
Equisetum arvense	—	—	—	—	—	+/2	—	3/30
Erigeron peregrinus	—	—	—	—	+/2	5/30	—	1/24
Erigeron subtrinervis	+/2	+/+	+/+	/+	—	—	—	—
Erythronium grandiflorum	1/24	—	+/8	+/2	1/12	1/34	+/6	—
Fragaria americana	—	+/4	—	+/2	—	—	—	11/88
Fragaria ovalis	+/6	—	—	—	+/8	2/34	—	/+
Galium boreale	1/14	+/2	+/8	+/4	+/18	1/28	1/22	4/50
Geranium fremontii	+/2	—	+/4	+/4	+/+	/+	2/26	—
Geranium richardsonii	—	—	—	—	+/12	14/62	—	16/82
Hieracium lanatum	—	—	—	—	+/4	—	—	3/16
Lathyrus leucanthus	—	12/94	—	—	/+	—	32/98	—
Ligusticum filicinum	+/2	4/22	—	—	+/2	21/64	—	1/6
Osmorhiza chilensis	—	—	—	4/24	—	—	—	—
Osmorhiza depauperata	+/2	—	—	1/34	+/12	2/56	21/94	2/48
Oxytropis campestris	18/80	—	3/26	—	8/16	—	—	—
Perideridia gairdneri	+/2	—	+/2	1/12	+/2	—	+/2	—
Potentilla diversifolia	—	—	—	+/+	+/8	1/12	—	—
Ranunculus eschscholtzii	—	—	—	+/2	—	—	—	—
Ranunculus sceleratus	—	—	—	—	—	1/6	—	—
Senecio eremophilus	—	—	+/+	1/3	—	—	—	—
Smilicina stellata	—	—	—	—	—	—	—	1/18
Stellaria jamesiana	—	—	—	9/80	+/6	—	—	—
Taraxacum officinale	7/74	12/88	+/2	+/4	3/40	7/74	—	+/10
Thalictrum fendleri	—	—	—	1/4	/+	1/24	—	6/32
Thlaspi alpestre	—	—	/+	1/18	—	+/2	—	—
Valeriana occidentalis	—	—	—	+/2	—	2/10	—	4/36
Vicia americana	4/26	44/94	+/2	18/72	24/92	1/24	4/34	—
Viola adunca	—	+/12	—	+/2	+/2	—	—	—
Viola nuttallii	+/6	+/6	+/2	1/20	+/12	1/28	5/44	—
Wyethia amplexicaulis	—	—	44/92	—	—	—	—	—
Moss and Lichen	+/2	—	—	—	—	—	—	—

\+ = *less than 0.5%.*

Table A-5.—Coverage (percent) and frequency (percent) of the undergrowth in stands in the *Pinus flexilis/Hesperachloa kingii* and *Pinus flexilis/Juniperus communis* habitat types.

	Pinus/Hesperochloa								*Pinus/Juniperus*	
Plot	282	280	283	246	247	252	298	264	290	297
Shrubs										
Amelanchier alnifolia	+/2	+/+	1/10	—	—	—	+/2	+/2	—	—
Arctostaphylos uva-ursi	—	—	—	—	/+	—	—	—	5/18	1/6
Artemisia filifolia	/+	—	/+	—	1/18	+/4	—	—	—	—
Artemisia frigida	1/18	—	—	+/6	—	—	—	—	+/4	—
Artemisia tridentata	4/18	+/6	1/4	/+	/+	—	+/2	1/2	—	—
Berberis (Mahonia) repens	/+	—	—	—	—	—	3/42	—	—	—
Ceanothus velutinus	—	—	—	—	—	—	6/12	+/+	—	—
Cercocarpus montanus	3/10	+/+	—	—	—	—	1/18	—	—	—
Juniperus communis	6/10	+/+	—	2/10	—	—	1/4	/+	5/60	14/24
Purshia tridentata	—	+/+	—	—	—	—	—	1/4	—	—
Ribes cereum	2/12	/+	—	+/4	+/4	/+	/+	—	/+	/+
Rosa woodsii	—	—	/+	—	—	—	+/2	—	—	—
Shepherdia canadensis	—	—	—	—	—	—	+/2	—	—	—
Symphoricarpos albus	—	/+	+/2	—	—	—	1/10	/+	—	—
Graminoids										
Agropyron spicatum	1/10	+/20	+/10	—	—	—	+/20	—	—	+/8
Carex geyeri	4/10	—	—	—	—	—	5/22	+/2	6/40	+/10
Carex rossii	+/2	—	—	—	—	+/6	1/10	1/34	1/14	1/12
Festuca idahoensis	—	+/6	—	—	—	—	—	/+	—	—
Festuca occidentalis	3/30	—	—	—	—	—	—	—	—	—
Festuca ovina	—	—	—	+/16	1/26	—	1/16	—	2/44	+/10
Hesperochloa kingii	10/50	7/46	3/32	4/22	5/36	4/48	3/44	/+	2/38	+/12
Koeleria cristata	+/4	+/6	+/6	+/18	3/60	1/14	+/6	+/+	—	—
Poa cusickii	3/30	—	1/12	1/34	3/34	1/18	—	—	—	—
Poa interior	—	—	—	1/18	—	+/8	—	—	+/2	/+
Poa nervosa	—	+/4	/+	—	—	—	—	1/24	/+	—
Poa sandbergii	—	—	+/2	/+	1/24	+/22	—	/+	+/14	—
Sitanion hystrix	—	—	—	—	+/4	/+	—	—		
Forbs										
Achillea lanulosa	+/2	—	—	+/10	/+	—	+/6	—	—	+/6
Allium brevistylum	—	—	—	1/44	1/26	1/30	/+	—	/+	—
Antennaria rosea	+/10	2/30	4/32	/+	+/2	+/2	+/2	+/14	5/32	+/8
Arabis drummondii	+/2	—	+/4	—	/+	—	—	+/4	+/8	+/2
Arenaria congesta	+/+	/+	1/22	+/14	1/24	2/50	3/66	+/26	5/48	+/2
Astragalus parryi	—	—	—	—	—	—	—	—	+/+	+/4
Astragalus spatulatus	—	+/2	—	4/14	/+	9/82	—	—	—	—
Balsamorhiza sagittata	+/2	+/2	—	—	—	—	/+	—	—	—
Besseya plantaginea	—	—	—	/+	/+	/+	—	—	—	—
Cerastium arvense	—	—	—	/+	+/4	+/8	—	—	—	—
Crepis acuminata	+/+	+/+	—	—	—	—	+/2	+/+	—	—
Delphinium nelsonii	+/+	+/+	—	—	—	—	—	+/+	—	—
Erigeron compositus	—	+/2	—	—	—	—	1/18	—	—	+/2
Erigeron flagellaris	+/2	+/4	+/4	1/26	+/10	1/26	2/50	/+	1/12	+/20
Erigeron umbellatum	1/2	/+	+/6	/+	—	+/+	—	+/+	/+	—
Frasera speciosa	—	—	—	—	+/2	+/2	1/14	—	+/2	+/6
Galium boreale	—	—	—	—	+/2	—	+/6	—	1/14	—
Geranium fremontii	—	—	—	+/2	—	—	/+	—	—	—
Harbouria trachypleura	—	—	—	+/4	+/2	9/68	—	—	+/4	—
Heterotheca villosa	/+	—	—	—	—	—	1/14	—	+/4	—
Hieracium albiflorum	—	—	—	—	—	—	+/2	/+	—	—
Hymenoxys acaulis	—	—	—	—	+/2	1/26	—	—	—	—
Leptodactylon pungens	—	—	—	—	+/8	1/36	—	—	—	—
Lesquerella montana	—	+/2	—	—	—	+/4	—	—	—	—
Lupinus argenteus	—	—	1/16	—	—	—	—	/+	17/68	+/4
Mertensia lanceolata	—	—	—	+/2	1/34	+/20	—	—	—	—
Oxytropis campestris	—	—	—	+/8	3/22	—	—	—	+/14	—
Oxytropis sericea	—	—	—	+/2	+/2	—	—	—	—	—
Penstemon virens	+/4	+/8	—	—	—	—	—	—	—	—
Penstemon whippleanus	—	—	—	—	—	—	+/4	—	+/14	—
Phlox multiflora	—	+/8	3/30	—	—	—	1/30	+/2	7/58	—
Potentilla diversifolia	—	—	+/6	/+	—	+/4	—	—	—	—
Potentilla fissa	+/2	+/2	1/8	—	+/2	/+	—	+/2	+/2	1/8
Pulsatilla ludoviciana	—	/+	1/14	—	—	—	1/24	+/8	+/10	/+
Ranunculus ranunculinus	—	—	—	—	2/46	—	—	—	—	/+
Sedum lanceolatum	—	/+	+/2	1/44	1/16	+/38	+/18	+/14	+/8	+/12
Senecio integerrimus	/+	—	—	—	+/2	+/10	—	+/10	—	/+
Solidago decumbens	—	—	—	—	—	—	/+	—	—	+/8
Taraxacum officinale	—	—	—	+/6	/+	—	+/2	—	—	—
Moss and Lichen	+/10	+/4	—	+/10	+/4	—	—	+/16	2/16	5/56

+ = less than 0.5%.

Table A-6.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Pinus contorta/Juniperus communis*, *P. contorta/Shepheria canadensis*, and *P. contorta/Carex rossii* habitat types.

	Pinus/Juniperus				*Pinus/ Shepherdia*		*Pinus/C. rossii*				
Plot	**256**	**250**	**251**	**259**	**281**	**292**	**142**	**22**	**253**	**227**	**150**
Shrubs											
Amelanchier alnifolia	—	—	—	—	—	+/2	—	—	—	—	—
Arctostaphylos uva-ursi	—	/+	+/+	—	/+	—	—	—	—	+/+	14/32
Berberis (Mahonia) repens	—	1/14	/+	/+	/+	3/28	—	/+	—	1/2	1/6
Chimaphila unbellata	—	—	—	—	—	1/8	—	+/+	—	—	/+
Clematis columbiana	—	—	—	—	—	+/2	—	—	—	/+	—
Juniperus communis	2/6	6/8	3/6	7/10	—	/+	—	—	1/4	/+	2/4
Linnaea borealis	—	—	—	—	—	8/24	—	—	—	—	—
Lonicera involucrata	+/4	—	—	—	—	+/2	—	—	—	—	—
Pyrola secunda	—	/+	—	+/+	/+	+/8	+/+	1/12	/+	/+	/+
Pyrola virens	—	—	—	/+	+/2	1/20	—	—	—	—	—
Rosa woodsii	1/24	+/2	+/2	+/2	/+	3/24	—	+/+	+/2	—	+/16
Shepherdia canadensis	—	+/4	/+	—	4/10	27/66	—	—	—	+/+	/+
Vaccinium caespitosum	—	—	—	—	—	—	—	6/44	+/+	—	—
Vaccinium myrtillus	—	—	—	—	—	—	+/+	—	—	—	—
Vaccinium scoparium	/+	—	—	—	—	2/6	9/34	—	1/10	—	—
Graminoids											
Agropyron trachycaulum	—	—	—	—	—	—	—	—	—	—	—
Bromus marginatus	—	—	—	—	—	—	—	—	1/20	—	—
Calamagrostis rubescens	—	—	—	—	—	—	—	—	—	—	—
Carex geyeri	+/12	+/+	/+	—	/+	+/+	—	—	—	—	—
Carex rossii	+/6	+/8	+/8	1/16	—	—	14/50	25/86	2/26	+/14	7/38
Elymus glaucus	/+	—	—	—	—	—	—	—	—	—	—
Festuca occidentalis	—	—	—	—	—	—	—	—	—	—	—
Melica subulata	1/8	—	—	—	—	—	—	—	—	—	—
Poa interior	+/+	+/10	—	—	—	—	—	—	+/8	—	—
Poa nervosa	1/36	+/6	—	1/8	/+	/+	/+	—	1/10	1/6	+/2
Poa reflexa	+/+	—	—	—	—	—	—	—	—	—	—
Stipa columbiana	—	—	—	—	—	—	—	—	—	—	—
Trisetum spicatum	+/8	+/2	—	/+	—	—	—	—	1/16	—	—
Forbs											
Achillea lanulosa	+/8	—	—	/+	/+	—	+/2	+/+	+/8	/+	/+
Antennaria rosea	+/4	—	/+	+/4	/+	—	+/2	—	4/64	/+	/+
Arnica cordifolia	5/50	1/24	1/30	/+	1/4	1/14	1/16	+/+	5/52	4/26	2/12
Aster engelmannii	4/62	—	—	—	+/6	—	—	—	—	—	—
Campanula rotundifolia	1/18	+/2	/+	+/8	—	—	—	+/2	—	+/6	—
Cirsium canescens	1/22	—	—	—	—	/+	/+	—	+/4	—	—
Corallorhiza maculata	—	—	—	+/+	—	—	—	—	—	—	—
Epilobium spp.	2/46	—	—	/+	/+	+/+	/+	+/2	5/42	—	+/8
Erigeron peregrinus	—	—	—	—	+/+	—	—	—	1/26	+/2	/+
Fragaria ovalis	9/68	—	—	/+	—	—	/+	+/2	2/20	—	1/12
Frasera speciosa	2/48	+/2	+/+	—	—	—	—	—	—	/+	—
Galium boreale	—	+/4	—	—	—	—	—	—	—	—	—
Geranium richardsonii	—	—	+/2	—	—	—	/+	—	—	+/2	—
Harbouria trachypleura	—	+/2	/+	—	—	—	—	—	—	+/4	—
Hieracium albiflorum	—	—	—	+/2	/+	—	1/20	—	+/6	—	—
Lesquerella montana	+/2	+/10	—	—	—	—	—	—	—	—	—
Ligusticum filicinum	—	—	—	—	—	/+	—	—	—	—	—
Lupinus argenteus	+/8	—	—	—	+/4	/+	—	—	—	—	8/32
Osmorhiza depauperata	+/2	—	—	—	—	—	/+	—	/+	—	—
Oxytropis campestris	27/68	—	—	—	—	—	—	—	—	—	—
Penstemon virens	—	+/2	—	—	—	—	—	—	—	—	—
Potentilla fissa	—	—	+/2	/+	—	—	—	/+	—	+/2	1/4
Pulsatilla ludoviciana	—	+/+	+/+	—	—	—	—	—	—	+/6	—
Ranunculus alismaefolius	—	—	—	—	—	—	—	—	+/18	—	—
Sedum lanceolatum	—	+/10	/4	—	/+	—	—	+/2	—	1/12	—
Solidago decumbens	+/+	1/14	+/4	+/16	—	—	+/6	1/12	—	+/8	1/4
Taraxacum officinale	+/6	—	—	—	—	—	+/+	—	4/70	—	—
Thermopsis divaricarpa	—	1/14	+/2	—	—	—	—	—	—	—	—
Viola adunca	+/10	—	—	—	—	—	—	—	—	—	—
Viola nuttallii	—	—	—	+/6	—	—	—	—	—	—	—
Moss and Lichen	+/12	3/20	—	1/14	2/14	7/50	+/2	2/18	1/12	1/16	1/6

+ = *less than 0.5%.*

Table A-7.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Pinus contorta/Carex geyeri* habitat type.

Plot	277	278	296	275	241	255	309	270
Shrubs								
Amelanchier alnifolia	—	—	/+	/+	—	/+	—	—
Actostaphylos uva-ursi	—	—	—	—	+/+	—	/+	—
Berberis (Mahonia) repens	+/+	—	4/46	+/+	+/2	+/4	2/42	—
Ceanothus velutinus	—	—	—	—	+/+	—	/+	—
Chimaphila unbellata	—	—	/+	—	+/2	/+	—	—
Juniperus communis	—	/+	+/2	/+	+/+	4/10	8/14	—
Pyrola secunda	—	—	—	—	—	—	—	—
Pyrola virens	—	—	+/4	—	+/+	/+	+/2	—
Rosa woodsii	—	—	1/34	/+	—	+/10	2/32	—
Shepherdia canadensis	—	—	/+	—	+/+	—	/+	—
Symphoricarpos albus	—	—	—	/+	—	+/+	—	—
Vaccinium caespitosum	—	5/22	—	—	—	—	—	24/78
Vaccinium myrtillus	—	—	—	—	—	/+	—	+/+
Vaccinium scoparium	—	—	—	—	—	—	—	—
Graminoids								
Agropyron trachycaulum	—	—	—	—	—	—	—	—
Bromus marginatus	—	—	/+	+/2	—	—	/+	—
Calamagrostis rubescens	—	—	—	—	—	—	—	41/76
Carex geyeri	16/40	4/68	18/64	32/72	+/6	5/26	27/62	3/10
Carex rossii	1/12	1/8	—	—	—	/+	—	1/10
Hesperochloa kingii	—	—	—	—	—	+/2	/+	—
Oryzopsis exigua	/+	/+	—	—	—	—	/+	—
Phleum alpinum	—	/+	—	—	—	—	—	—
Poa cusickii	—	—	—	—	+/4	—	—	—
Poa nervosa	+/16	/+	1/8	+/+	—	—	—	+/4
Stipa lettermanii	—	—	—	+/+	—	—	—	/+
Trisetum spicatum	—	+/2	—	—	—	—	—	+/2
Forbs								
Achillea lanulosa	+/+	—	+/2	—	/+	/+	+/+	/+
Antennaria rosea	/+	—	—	—	/+	—	+/2	+/2
Apocynum androsaemifolium	—	—	—	—	/+	—	—	—
Arenaria fendleri	/+	—	—	—	+/+	—	—	—
Arnica cordifolia	+/6	—	+/10	7/60	/+	+/10	+/12	6/50
Aster glaucodes	—	—	+/6	—	—	—	—	
Campanula rotundifolia	—	—	+/+	/+	/+	/+	/+	—
Cirsium canesce	/+	—	—	—	—	+/2	+/4	—
Collomia linearis	—	—	—	—	+/4	—	—	—
Corallorhiza maculata	/+	/+	—	—	—	—	—	—
Epilobium spp.	—	—	+/4	—	+/+	/+	—	+/+
Erigeron peregrinus	—	—	+/2	—	/+	—	+/12	—
Erythronium grandiflorum	—	—	—	—	—	—	—	—
Fragaria americana	—	—	—	/+	+/+	—	—	/+
Fragaria ovalis	—	—	+/2	—	—	—	+/2	—
Galium boreale	—	—	—	+/2	—	—	+/4	+/+
Geranium fremontii	—	—	—	—	—	—	—	—
Hieracium albiflorum	+/4	+/2	+/4	—	+/12	—	—	—
Hieracium gracile	—	—	—	—	—	—	—	—
Ligusticum filicinum	—	—	—	/+	—	—	—	+/+
Lupinus argenteus	11/60	—	5/46	—	+/+	—	+/4	—
Osmorhiza depauperata	—	—	—	+/10	—	—	—	+/4
Oxytropis campestris	—	—	4/20	/+	—	/+	—	7/54
Potentilla spp.	—	—	—	—	/+	/+	—	—
Pterospora andromedea	—	—	/+	+/+	—	—	/+	—
Pulsatilla ludovicina	—	—	—	—	—	—	—	—
Solidago decumbens	+/+	/+	—	+/2	/+	+/2	+/6	+/+
Ranunculus alismaefolius	—	—	—	—	—	—	—	—
Taraxacum officinale	—	—	+/+	—	—	—	—	—
Viola adunca	—	—	—	—	—	—	—	—
Moss and Lichen	—	1/6	+/4	+/4	+/12	+/2	1/16	—

+ = *less than 0.5%.*

Table A-8.—Coverage (percent) and frequency (percent) of undergrowth species in stands in the *Pinus contorta/Vaccinium scoparium* habitat type.

Plot	60	135	306	173	175	201	47	312	307	313
Shrubs										
Arctostaphylos uva-ursi	—	—	—	—	—	—	—	—	—	—
Crataegus erythoropoda	—	—	—	—	—	—	1/12	—	—	—
Berberis (Mahonia) repens	—	1/4	—	/ +	2/26	—	/ +	+ /4	/ +	+ /6
Juniperus communis	/ +	/ +	+ /4	+ / +	+ /2	—	/ +	/ +	/ +	1/6
Pyrola secunda	—	1/16	—	—	—	—	1/4	—	—	—
Pyrola virens	—	—	/ +	—	—	—	—	1/10	—	+ /2
Rosa woodsii	—	1/6	/ +	—	+ /6	—	/ +	—	—	1/16
Shepherdia canadensis	—	/ +	—	—	—	—	/ +	/ +	—	/ +
Vaccinium caespitosum	—	—	—	—	—	—	—	—	+ / +	—
Vaccinium myrtillus	—	—	—	—	—	—	—	—	—	—
Vaccinium scoparium	24/82	57/100	59/100	49/94	31/100	50/98	67/98	53/100	27/84	16/84
Graminoids										
Calamagrostis canadensis	—	—	—	—	—	—	+ /6	—	—	—
Carex geyeri	—	—	4/40	—	—	—	—	—	3/18	3/12
Carex rossii	13/70	1/ +	—	1/12	8/86	3/24	+ /2	+ /4	+ /2	5/42
Oryzopsis asperifolia	—	—	—	—	—	—	—	—	—	2/18
Poa nervosa	+ /6	/ +	—	1/4	+ /2	—	—	—	/ +	+ /4
Trisetum spicatum	—	—	/ +	—	—	—	/ +	—	/ +	+ /8
Forbs										
Achillea lanulosa	+ / +	—	—	+ /6	—	—	—	—	/ +	—
Antennaria rosea	/ +	—	—	1/4	+ / +	—	+ /2	—	/ +	2/30
Arenaria congesta	1/12	—	—	—	—	—	—	—	—	—
Arnica cordifolia	+ /6	1/26	1/36	2/30	6/64	—	5/56	+ /2	+ /6	1/14
Campanula rotundifolia	—	—	—	—	+ / +	—	/ +	—	—	+ /2
Cirsium canescens	+ / +	—	—	—	—	—	—	—	—	—
Claytonia lanceolata	—	—	—	1/4	+ /8	—	—	—	—	—
Epilobium angustifolium	/ +	+ /2	—	+ /4	+ /2	/ +	1/16	+ /8	/ +	+ /8
Erigeron glabellus	—	—	—	3/40	/ +	—	—	—	—	—
Erigeron peregrinus	+ / +	/ +	/ +	—	+ / +	—	+ /6	—	—	—
Erythronium grandiflorum	—	—	—	/ +	/ +	—	—	—	—	—
Fragaria ovalis	—	+ /2	—	—	—	—	+ /8	—	—	—
Geranium richardsonii	+ / +	—	—	—	—	—	—	—	—	—
Hieracium albiflorum	—	/ +	+ /2	+ /12	1/18	—	—	—	—	1/28
Hieracium gracile	+ / +	—	—	—	—	1/6	2/18	—	—	—
Lupinus argenteus	—	1/12	+ /2	—	—	—	—	—	—	5/36
Osmorhiza depauperata	—	—	—	—	—	—	—	—	—	—
Pedicularis racemosa	+ / +	—	—	—	—	—	—	—	—	—
Senecio crassulus	—	—	—	—	—	—	—	—	—	—
Solidago decumbens	+ /8	/ +	/ +	—	—	—	2/24	/ +	—	+ /2
Zygadenus elegans	+ / +	—	—	—	—	+ / +	+ /2	—	—	—
Moss and Lichen	—	+ /4	+ /2	2/2	—	1/8	—	+ /18	+ /18	3/44

+ = *less than 0.5%.*

Table A-9.—Coverage (percent) and frequency (percent) of undergrowth species in stands of the *Abies lasiocarpa/Carex geyeri* and *Abies lasiocarpa*/Moss habitat types

Plot	*Abies/Carex*				*Abies*/Moss		
	287	110	286	284	314	299	248
Shrubs							
Amelanchier alnifolia	—	/+	+/+	—	—	—	—
Berberis (Mahonia) repens	/+	+/4	+/8	—	—	—	—
Chimaphila umbellata	—	/+	1/4	—	—	—	—
Clematis columbiana	—	—	+/+	—	—	—	2/12
Juniperus communis	+/2	/+	3/10	4/10	+/+	—	+/4
Lonicera involucrata	—	+/+	—	—	—	—	+/2
Pyrola secunda	—	2/14	+/+	—	/+	—	1/24
Ribes montigenum	—	—	—	—	—	—	+/2
Rosa woodsii	—	2/12	1/36	—	—	—	2/20
Shepherdia canadensis	—	—	/+	—	—	—	+/4
Vaccinium myrtillus	—	—	—	—	+/8	+/+	—
Vaccinium scoparium	—	—	2/26	—	+/12	/+	—
Graminoids							
Agropyron subsecundum	+/4	—	+/6	1/18	—	—	—
Bromus ciliatus	+/6	—	—	—	—	—	—
Bromus marginatus	—	—	+/+	2/36	—	—	—
Calamagrostis rubescens	+/6	—	—	+/12	—	—	—
Carex geyeri	29/90	17/64	4/26	39/84	—	—	2/16
Carex rossii	—	—	+/4	—	1/8	—	—
Elymus glaucus	8/64	—	/+	—	—	—	—
Festuca ovina	—	—	—	—	+/10	—	—
Melica subulata	—	—	—	—	—	—	+/4
Oryzopsis asperifolia	—	—	1/24	/+	—	—	—
Poa epilis	+/2	—	—	—	+/2	+/6	—
Poa interior	—	—	—	—	—	—	/+
Poa nervosa	—	—	—	2/20	7/46	—	—
Poa reflexa	—	—	—	—	+/16	2/18	—
Trisetum spicatum	+/6	—	/+	+/8	+/10	—	—
Forbs							
Achillea lanulosa	1/8	—	—	+/4	+/2	/+	+/2
Agoseris glauca	+/2	—	—	—	—	—	—
Allium brevistylum	2/24	—	—	—	—	—	—
Antennaria rosea	—	—	/+	—	+/4	—	+/8
Arnica cordifolia	2/18	19/88	9/94	3/20	—	+/2	3/48
Aster engelmannii	1/8	/+	—	—	—	—	—
Bistorta bistortoides	—	—	—	—	+/6	/+	—
Caltha leptosepula	—	—	—	—	+/10	—	—
Castilleja septentrionalis	—	+/+	—	—	—	—	—
Cirsium canescens	+/4	+/+	+/2	/+	—	—	—
Delphinium occidentalis	+/4	—	—	—	—	—	—
Draba crassifolia	—	—	—	—	+/2	+/4	—
Epilobium spp.	—	—	—	—	—	+/2	/+
Erigeron peregrinus	1/14	1/4	5/20	+/+	2/30	+/2	—
Erythronium grandiflorum	—	—	+/2	+/4	+/6	+/2	—
Fragaria ovalis	1/26	—	1/16	—	—	—	—
Galium boreale	1/20	+/+	2/28	—	—	—	+/2
Hieracium gracile	—	—	1/16	—	+/6	/+	—
Lewisia pygmea	—	—	—	—	—	+/+	+/2
Ligusticum filicinum	7/64	—	2/18	1/20	—	/+	—
Lomatium dissectum	—	/+	—	—	—	+/6	—
Osmorhiza depauperata	10/70	1/24	+/+	3/58	—	—	—
Oxytropis campestris	13/50	—	—	22/60	—	—	—
Potentilla diversifolia	—	—	—	/+	+/6	—	+/2
Ranunculus eschscholtzii	—	—	—	—	/+	/+	—
Senecio amplectens	—	—	—	—	—	—	—
Senecio crassulus	—	—	—	—	/+	—	—
Senecio dimorphophyllus	—	—	—	—	1/18	+/2	—
Senecio serra	—	—	—	—	—	—	—
Sibbaldia procumbens	—	—	—	—	+/8	/+	—
Stellaria jamesiana	—	—	—	—	+/10	4/12	—
Taraxacum officinale	17/72	—	—	12/86	—	—	—
Thlaspi alpestre	—	—	—	—	1/12	/+	—
Trollius laxus	—	—	—	—	+/+	—	—
Viola adunca		— —	+/2	+/4	1/58	—	—
Viola nuttallii	2/36	—	—	—	—	—	—
Zygadenus elegans	—	—	+/2	—	—	—	—
Moss and Lichen	+/2	—	+/4	+/2	20/30	4/30	21/94

+ = *less than 0.5%.*

Table A-10.—Coverage (percent) and frequency (percent) of undergrowth species in stands

	Stand Number																	
	293	224	315	316	268	294	300	34	43	66	68	95	116	120	131	223	225	232
Shrubs																		
Arctostaphylos uva-ursi	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	/ +	—	/ +
Berberis (Mahonia) repens	—	—	—	—	—	—	—	—	—	—	—	/ +	—	—	—	—	—	—
Chimaphila umbellata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Clematis columbiana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Juniperus communis	—	—	—	—	—	—	—	—	—	—	—	/ +	—	—	—	/ +	—	—
Lonicera involucrata	—	—	—	—	—	—	—	+ / +	—	—	—	—	—	—	—	—	—	2/6
Pyrola asarifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2/12
Pyrola secunda	—	—	—	—	+ /2	—	—	—	—	—	—	—	—	1/2	/ +	—	—	1/6
Pyrola virens	—	—	—	—	—	—	—	—	—	—	—	—	—	/ +	—	—	—	—
Ribes lacustre	—	—	—	—	—	—	/ +	—	—	—	—	—	—	—	—	—	—	—
Ribes montigenum	—	—	—	—	—	—	—	—	—	/ +	—	/ +	—	—	—	—	—	—
Rosa woodsii	—	—	—	—	—	—	—	—	—	—	—	/ +	—	—	—	—	—	+ /2
Rubus parviflorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Shepherdia canadensis	—	—	—	—	—	—	—	—	—	—	—	—	+ / +	—	—	—	—	—
Vaccinium caespitosum	—	—	—	+ /2	/ +	—	—	—	—	—	—	—	—	—	—	—	—	3/34
Vaccinium myrtillus	—	—	+ /4	/ +	—	—	—	—	—	—	+ / +	—	—	—	/ +	—	—	—
Vaccinium scoparium	35/94	3/8	22/42	44/92	3/20	9/50	21/78	81/100	71/100	56/94	45/84	51/94	74/96	39/88	62/100	69/96	43/82	55/100
Graminoids																		
Agropyron subsecundum	—	—	—	—	+ / +	—	—	/ +	—	—	—	+ / +	1/6	—	—	—	—	—
Bromus ciliatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bromus marginatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Calamagrostis canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Carex ebenea	—	—	+ /2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Carex geyeri	—	—	—	—	1/10	+ /2	—	—	—	—	—	26/78	—	—	—	—	—	—
Carex rossii	1/14	1/12	2/26	1/16	—	—	1/16	+ / +	—	+ /6	—	—	—	—	1/12	1/12	/ +	+ /2
Elymus glaucus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Koeleria cristata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Poa epilis	—	—	—	+ /8	—	—	2/36	—	—	—	+ /8	—	—	—	—	—	+ /8	—
Poa nervosa	/ +	—	+ /4	2/28	—	—	/ +	—	—	—	—	3/20	—	—	—	+ /4	—	—
Poa reflexa	/ +	—	+ /10	1/12	/ +	+ /6	+ /12	—	—	—	2/10	—	—	—	—	—	/ +	—
Trisetum spicatum	/ +	—	2/40	+ /8	—	+ /6	—	—	+ /2	—	—	—	—	—	—	—	—	—
Forbs																		
Achillea lanulosa	—	+ /6	1/14	+ /16	—	/ +	/ +	/ +	/ +	—	—	/ +	—	—	+ / +	—	/ +	/ +
Antennaria rosea	—	/ +	1/8	+ /2	—	—	+ /2	—	—	—	—	/ +	—	—	—	—	—	—
Arnica cordifolia	/ +	1/18	+ /16	+ /4	2/38	1/32	1/28	1/12	1/6	+ /16	—	9/50	4/40	1/12	1/24	4/24	3/28	6/56
Arnica latifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	/ +	/ +	—
Aster engelmannii	—	—	—	—	—	—	—	—	—	—	—	—	1/16	/ +	—	—	—	—
Bistorta bistortoides	+ / +	/ +	/ +	+ /8	—	—	1/12	—	—	—	+ /2	—	—	—	—	—	—	—
Caltha leptosepula	—	—	+ / +	—	/ +	/ +	+ /12	—	—	—	—	—	—	—	—	—	—	+ / +
Claytonia lanceolata	—	+ / +	—	—	—	—	—	—	—	—	+ /4	—	—	—	+ / +	—	+ /4	—
Draba crassifolia	—	—	+ /4	+ /4	—	—	+ /2	—	—	—	—	—	—	—	—	—	—	—
Epilobium angustifolium	/ +	/ +	+ /8	—	—	/ +	—	/ +	—	/ +	—	—	+ /2	+ / +	—	—	—	/ +
Erigeron peregrinus	+ / +	+ /4	2/36	4/48	1/18	3/32	4/42	+ /2	6/40	—	3/26	2/18	+ /2	+ /6	10/46	—	1/26	8/50
Erythronium grandiflorum	/ +	1/12	1/28	+ /2	/ +	+ /4	1/30	/ +	+ /8	—	1/14	—	—	+ / +	/ +	—	+ /2	+ /2
Fragaria americana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1/8
Fragaria ovalis	—	—	/ +	—	/ +	—	—	—	—	—	—	/ +	—	—	+ /4	—	—	—
Galium boreale	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	/ +	—
Geranium fremontii	—	—	—	—	—	—	—	+ / +	—	—	—	—	—	—	—	—	—	1/24
Geranium richardsonii	—	—	—	—	—	—	—	—	—	—	—	—	/ +	—	—	—	+ /2	—
Heuchera parviflora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hieracium albiflorum	—	—	—	—	—	—	—	—	—	—	—	1/18	—	—	—	/ +	—	+ /2
Hieracium gracile	+ /2	—	2/36	3/40	—	+ /2	1/12	+ /2	4/44	—	2/24	1/6	/ +	/ +	—	1/14	6/30	—
Liqusticum filicinum	—	—	1/18	+ /12	1/18	/ +	+ /8	—	—	—	—	—	—	—	—	—	—	—
Lomatium disectum	—	—	—	—	—	—	—	—	—	—	—	+ /2	+ / +	+ /2	1/8	+ / +	+ /2	4/26
Lupinus argenteus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Osmorhiza depauperata	—	—	—	—	1/16	—	—	—	—	—	—	/ +	+ /4	1/6	+ /2	/ +	+ /2	1/10
Pedicularis bracteosa	—	+ /2	—	—	/ +	—	/ +	1/6	—	—	/ +	+ / +	—	—	/ +	—	/ +	—
Pedicularis racemosa	—	+ / +	—	—	—	—	—	1/4	/ +	+ /2	+ / +	6/30	+ /2	—	/ +	1/4	+ / +	—
Potentilla diversifolia	—	+ /2	+ /6	/ +	—	/ +	—	—	—	—	—	—	—	—	—	—	—	—
Ranunculus eschscholtzii	—	/ +	—	+ /4	—	+ /6	+ /12	—	—	—	—	—	—	—	—	—	+ /6	/ +
Senecio crassulus	—	1/10	—	—	—	—	—	—	—	2/26	/ +	—	—	—	—	—	—	—
Senecio dimorphophyllus	—	+ /2	3/26	2/46	—	1/20	1/32	—	—	—	—	—	—	—	—	—	/ +	—
Senecio triangularis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sibbaldia procumbens	—	+ /2	1/10	+ /8	—	/ +	+ /6	—	+ /4	—	—	—	—	—	—	—	+ /4	—
Solidago decumbens	—	—	—	—	—	—	—	+ / +	—	—	—	/ +	—	—	—	—	—	—
Stellaria jamesiana	—	—	/ +	—	—	—	—	—	—	—	—	—	+ /2	—	—	—	—	—
Taraxacum officinale	—	—	+ /2	—	—	—	—	—	—	—	—	—	—	—	—	/ +	—	—
Thalictrum fendleri	—	/ +	—	—	—	—	—	—	—	—	—	—	—	—	—	+ / +	—	+ /4
Thlaspi alpestre	/ +	—	+ /14	+ /18	+ / +	+ /6	+ /6	—	—	+ / +	+ /2	/ +	—	—	—	—	+ /2	—
Trollius laxus	—	—	—	+ /2	—	+ /4	+ /2	—	—	—	—	—	—	—	—	—	—	—
Viola adunca	—	1/12	—	+ /2	—	—	—	—	—	—	—	—	—	—	—	—	+ /2	—
Viola nuttallii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	/ +	—
Zygadenus elegans	—	+ /10	—	—	—	+ /2	—	—	—	—	—	—	—	—	—	—	—	1/16
Moss and Lichen	1/32	1/12	5/32	4/28	2/28	3/34	1/8	—	—	3/28	4/24	—	—	6/24	11/34	5/18	11/40	2/4

+ = *less than 0.5%.*

(listed by stand number) of the *Abies lasiocarpa/Vaccinium scoparium* habitat type.

233	260	283	276	285	301	302	311	226	261	279	295	158	192	230	234	236	254	267	120	4	289	30	285
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+/2
—	—	—	—	—	—	—	—	—	—	—	—	/+	+/2	—	+/2	—	—	—	—	/+	—	/+	+/2
—	—	—	—	—	—	—	—	—	—	—	—	—	/+	—	/+	—	—	—	—	/+	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	/+	—	+/2	2/2	—	—	—	—	—	—	1/2	—	/+	—
—	—	/+	—	+/+	—	—	—	—	+/+	—	/+	—	—	—	—	—	—	/+	—	+/2	—	—	—
—	—	—	+/4	—	—	—	—	—	+/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/+	—	+/14	—	+/4	—	—	+/2	—	1/14	—	+/2	—	/+	—	—	—	—	—	—	+/2	+/2	/+	/+
—	—	+/2	+/+	/+	—	—	—	—	—	+/2	—	/+	—	—	—	—	—	—	—	2/14	—	—	—
—	—	—	—	—	—	—	—	—	2/6	—	/+	—	—	—	—	—	—	+/10	—	—	—	—	—
/+	—	—	—	—	—	—	—	1/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	+/4	—	—	—	2/20	—	—	—	—	—	—	—	—	—	—
—	—	—	—	/+	—	—	—	—	—	—	—	—	+/+	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	+/2	—	—	—	1/2	—	—	—	—	—	—	/+	+/+	—	—
—	—	—	—	—	—	—	—	—	3/22	—	—	—	—	—	—	—	—	—	—	/+	—	14/62	—
—	—	+/4	6/62	5/28	1/24	—	/+	—	—	+/14	1/20	—	—	—	—	—	7/72	—	+/+	—	—	13/28	3/40
52/96	48/96	37/76	59/72	6/42	41/48	7/42	37/64	69/96	10/50	47/90	57/98	74/100	51/98	15/42	48/90	71/100	31/96	2/10	49/72	81/100	8/42	73/98	50/90
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+/2	—	—	—
—	—	—	—	/+	—	—	—	—	—	+/2	—	—	—	—	—	—	—	+/2	—	—	—	—	—
—	—	—	—	—	—	—	—	+/10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	5/24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	3/8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4/20	—	—	6/28	—	—	—	—	—	—	—	—	+/+	+/2	—	16/58	+/4	—	—	—	—	—	—	—
—	—	+/6	—	—	+/6	3/38	2/12	—	/+	/+	—	—	—	+/8	—	—	+/2	+/2	9/30	/+	/+	+/2	+/8
—	—	—	/+	—	—	—	—	—	/+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	+/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	+/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1/8	—	—	—	—	+/4	—	—	—	—	—	—	—	—	1/18	+/2	—	—	4/16	—	—	+/2	+/2	+/10
—	—	—	+/2	+/4	+/4	+/14	3/32	+/4	/+	—	—	—	+/6	—	—	/+	—	—	3/6	—	1/2	—	—
—	—	—	—	+/2	—	+/10	1/12	—	—	—	—	—	+/4	—	—	—	—	+/6	+/6	—	+/2	—	/+
/+	—	—	—	—	—	/+	—	—	—	—	—	—	—	—	—	—	—	1/8	—	—	—	—	/+
—	—	—	—	—	/+	1/10	+/2	—	—	/+	—	—	—	+/+	+/+	—	—	—	/+	/+	—	—	+/2
8/64	+/6	1/24	4/44	3/18	/+	—	—	+/+	3/58	2/42	/+	/+	6/44	+/2	8/62	—	1/18	+/4	1/12	1/8	+/4	/+	4/4
—	1/6	+/10	/+	/+	—	—	1/18	/+	—	—	—	—	—	—	/+	—	—	—	+/+	—	—	—	—
—	—	—	—	—	—	—	—	—	—	/+	—	—	—	—	+/4	—	—	+/8	—	—	—	—	—
—	—	—	—	—	—	/+	+/6	—	—	—	—	—	—	—	—	—	—	—	—	—	+/+	—	—
—	—	—	+/+	7/34	—	—	/+	—	—	—	—	—	—	—	—	—	—	—	—	—	1/6	—	—
—	—	—	—	—	—	—	+/8	—	—	—	—	—	—	3/30	—	—	—	1/14	—	—	/+	—	—
—	—	—	—	—	—	+/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
/+	+/+	—	—	+/2	—	—	—	+/+	+/6	+/8	—	1/14	—	+/+	+/2	/+	+/4	/+	/+	1/4	—	/+	+/4
1/14	2/10	+/8	1/20	3/28	—	—	6/34	+/+	3/38	1/20	—	—	+/4	—	1/12	—	1/6	+/10	/+	+/4	4/34	—	+/12
—	+/2	—	—	+/4	+/16	+/8	—	—	1/14	—	—	—	—	+/4	+/+	—	—	1/16	/+	—	+/20	—	—
—	—	—	—	+/6	—	—	—	—	1/18	+/4	—	—	—	—	—	—	—	—	+/+	—	—	—	—
+/+	—	—	—	—	—	—	—	—	—	—	—	—	+/+	—	+/2	—	—	—	—	1/14	—	—	—
—	—	—	—	—	—	—	—	1/26	—	—	—	/+	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	/+	—	—	—
—	—	—	+/+	2/26	—	/+	—	—	+/12	—	—	—	—	—	—	—	—	+/2	—	—	—	—	—
—	—	+/2	—	+/8	—	—	—	—	—	—	—	—	—	—	—	—	—	+/4	+/+	—	—	—	—
—	—	—	—	—	—	—	—	—	—	+/10	—	—	3/28	—	+/10	—	—	—	—	—	—	/+	+/18
+/6	—	—	—	—	1/26	1/30	5/44	3/16	/+	—	—	+/+	—	—	2/12	/+	—	—	2/8	—	—	+/+	+/12
—	+/2	—	/+	—	—	+/4	—	—	+/6	—	—	—	—	—	—	—	—	6/54	—	—	+/14	—	—
/+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	/+	/+	—	—	—
+/+	—	—	—	—	—	—	—	—	—	—	—	—	+/+	—	—	—	—	—	—	—	—	/+	/+
/+	—	1/6	+/+	1/14	—	—	—	—	—	+/4	—	—	/+	+/+	+/+	—	/+	1/12	—	1/6	—	—	+/2
+/2	/+	—	—	/+	—	—	+/2	/+	—	—	—	—	—	—	—	—	—	+/2	—	—	/+	—	—
/+	/+	/+	/+	—	—	—	—	9/28	—	—	—	—	—	—	—	—	—	+/2	—	—	+/+	+/+	—
—	—	—	—	—	—	/+	—	—	—	—	—	—	—	—	—	—	—	+/+	—	—	—	—	—
—	—	—	—	/+	—	—	/+	+/+	—	—	—	—	—	—	—	—	—	—	—	—	1/16	—	—
—	—	—	—	—	—	—	—	+/2	—	/+	—	—	—	—	—	—	—	—	—	—	+/4	—	+/2
—	—	—	—	—	—	—	+/6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	+/+	4/18	—	8/34	2/22	—	—	—	—	—	—	—	—	—	—	1/36	—	—	+/4	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+/+	1/8	—	—	—
—	—	—	—	—	—	—	—	—	—	1/26	—	/+	/+	—	/+	—	—	—	/+	+/+	—	+/2	+/10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	+/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	+/10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	+/2	/+	—	+/+	—	—	—	—	—	—	—	—	—	+/2	—	—	/+	—	—
—	—	—	—	+/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+/6	—	—
—	—	—	—	—	—	—	—	+/+	/+	—	—	—	—	—	—	—	—	—	—	/+	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+/12	—	—	—	—	—
/+	—	—	—	—	—	—	—	—	+/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2/20	6/46	7/24	7/34	+/6	2/28	13/28	+/2	3/38	1/24	5/32	—	—	2/16	—	—	10/38	+/4	—	—	11/64	/+	+/6

Alexander, Robert R., George R. Hoffman, and John M. Wirsing. 1986. Forest vegetation of the Medicine Bow National Forest in southern Wyoming: A habitat type classification. USDA Forest Service Research Paper RM–271, 39 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

A vegetation classification based on concepts and methods developed by Daubenmire and refined by others were used to identify 16 forest habitat types on the Medicine Bow National Forest. Included were two habitat types in the *Pinus flexilis* series; three each in the *Pinus ponderosa*, *Populus tremuloides*, and *Abies lasiocarpa* series; and five in the *Pinus contorta* series. A key to identify the habitat types and the management implications associated with each are provided.

Keywords: Vegetation classification, habitat type, *Picea engelmannii*, *Abies lasiocarpa*, *Pinus contorta*, *Populus tremuloides*, *Pinus flexilis*, *Pinus ponderosa*

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Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

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